AFAPL-TR-68-88

DESIGN POINT TURBINE ENGINE PERFORMANCE PROGRAM

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TECHNICAL REPORT AFAPL-TR-68-88

SEPTEMBER 1968

AIR FORCE AERO PROPULSION LABORATORY
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

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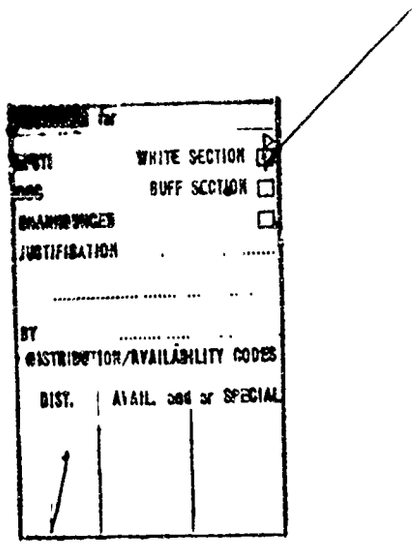

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200 - December 1968 - CO455 - 59-1371

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FOREWORD

This report was prepared in the Components Branch (APTC), Turbine Engine Division, Air Force Aero Propulsion Laboratory, Wright-Patterson Air Force Base, Ohio, under Project 3066, "Gas Turbine Technology," Task 306603, "Advanced Engine Studies," with Charles E. Bentz as Project Engineer.

This report covers work conducted within the Components Branch in the time period between July 1965 and June 1968.

This technical report has been reviewed and is approved.

ERNEST C. SIMPSON
Chief, Turbine Engine Division
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ABSTRACT

This report describes a digital computer program titled CARPET. CARPET is a computer program that calculates parametric turbojet/turbofan engine performance. It can also analyze the performance of a specific engine. The program is written in Fortran IV language and was designed for use on an IBM 7090 Digital Computer. Included in the report are listings of the complete program, various sample input data, and the corresponding output.

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SECTION I

GENERAL DISCUSSION

The CARPET Deck is a computer program that simulates a basic parametric turbojet or turbofan. It can also be used to analyze the performance of a specific engine at discrete operating points if the total airflow is input along with the component characteristics of the engine.

This program is written in FORTRAN IV and requires no special routines or setups. NAMELIST input is used to input data since it retains input values from case to case unless specifically changed in a particular data case. This eliminates continuously inputting parameters that do not change from case to case.

Provisions are included for a title which prints at the top of each page. The output format prints one data case per page within an 8 1/2 x 11 inch area with sufficient room for margins.

Since this program is not a component balancing program, a component performance map is not required.

SECTION II

HOW TO USE CARPET

Time Estimate: Load Time 45 Seconds

Run Time 0.5 Seconds/Data Case

Line Estimate: 55 Lines Per Data Case

NAMELIST Input: All of the data cards must start in Column 2 or beyond. To start a data case, punch $INPUT in Columns 2 - 7, then skip a space and continue by punching the input parameter names and the value you wish them to be equal to. Finish that data case by punching a $ - sign immediately following the last value in that data case. The program then executes that data case and comes back to the data cards for the next case.

The advantage of this input technique is that the program will use values from the preceding point unless specifically changed in the data case that follows. (See Example 1, Setup of CARPET Deck.)

Behind the last data case a card with $EØF punched in Columns 1 - 4 must be inserted to end the run.

Title Card: Provisions have been included to read a title card which is printed at the top of each output printout. To read a title card, set ITITLE = 1 in the NAMELIST data case to which the title applies. The program then reads Columns 1 - 66 of the first card following that data case as the title. Since the program automatically sets ITITLE = 0 after a title has been read, ITITLE has to be set = 1 only when a new title is desired.

SECTION III

DISCUSSION OF ROUTINES

CARPET: This is the main program and contains all of the normal input and output statements. It also contains all of the logic necessary to simulate a basic parametric turbojet or turbofan. Straight-through programming is used which makes following program logic quite easy.

Subroutine required: DSDRIV

This subroutine is set up to run "Design Derivatives" of a base case. Basically, this routine automatically varies designated engine input parameters by either a ± percent or a ± increment. In addition to doing this autoatically, this routine prints a subtitle designating the base case and each of the derivative cases including the increment and percent of change for that particular parameter. Printed at the bottom of the output are the ratios $SFC/(SCF_{BASE})$ and $FN/(FN_{BASE})$.

Data setup is as follows:

a. Set IDEL = 1 in the base case.

b. Also set ITITLE = 1 and include title card immediately after base case if desired.

c. Next sequence on data cards the parameters desired to be varied in Col. 1 - 6, the type of variance in Col. 11 - 16 (percent change - PERCNT or increment change - DELTA), and the value of the variance in Col. 21 - 30 (Note: 0.01 = 1%). If a variation in only one direction (+ or -) is desired, follow then with the direction indicator in Col. 31 - 36 (PLUS or MINUS).

d. After the last parameter varying card, a card must follow with GØØN punched in Col. 1 - 4.

NOTE: The parameters to be varied must appear in the name common PARAM.

Successive data cases will be run with the same design derivatives unless IDEL is set = 0.

RAM:

Routine for calculating Mil. Spec. 5008B ram recovery.

Calling sequence:

CALL RAM (AM, ETAR)

AM - Flight Mach Number

ETAR - Ram Recovery

CØMP:

Routine for calculating compressor or fan exit thermodynamic conditions.

Calling sequence:

CALL COMP (PR, ETA, PI, TI, SI, HI, PØ, TØ, SØ, HØ, IER)

PR - Compressor Pressure Ratio

ETA - Compressor Adiabatic Efficiency

PI, PØ - Total Pressures Into and Out of Compressor (Units In Atmospheres)

TI, TØ - Total Temperatures Into and Out of Compressor

SI, SØ - Entropy

HI, HØ - Enthalpy

IER - Error Indicator,

0 = No Error

1 = Error In Entropy Balance

Subroutines Required: THERMØ, PRØCØM.

CØMB:

Routine for calculating combustor and duct-burner thermodynamic exit conditions.

Calling sequence:

CALL COMB (PI, TØ, HI, ETA, DPB, PØ, HØ, SØ, FARØ, HV)

PI, PØ	- Combustor Inlet and Exit Total Pressures (Units In Atmospheres)
TØ	- Combustor Exit Total Temperature
HI, HØ	- Enthalpy
ETA	- Combustion Efficiency (i.e., Applied to Heating Value of Fuel)
DPB	- Total Pressure Drop Across Combustor
SØ	- Entropy At Combustion Exit
FARØ	- Combustor Exit Fuel to Air Ratio
HV	- Heating Value of Fuel (JP-4)

Subroutines Required: THERMØ, PRØCØM, AFQUIR.

TURB:

Routine for calculating turbine thermodynamic exit conditions.

Calling sequence:

CALL TURB (PI, HI, SI, FARI, ETA, DHTI, PØ, TØ, HØ, SØ, IER)

PI, PØ	- Turbine Inlet and Exit Total Pressures (Units In Atmospheres)

HI, HØ - Enthalpy

SI, SØ - Entropy

FARI - Fuel to Air Ratio Into Turbine

ETA - Turbine Adiabatic Efficiency

DHTI - Total Enthalpy Change Across Turbine Per Pound of Mass Flow Into Turbine

TØ - Turbine Exit Total Temperature

IER - Error Indicator

0 = No Error

1 = Error In Entropy Balance

Subroutines Required: THERMØ, PRØCØM.

ABFIRE:

Routine for calculating afterburner thermodynamic exit conditions.

Calling sequence:

CALL ABFIRE (PI, TØ, HI, FARI, ETA, DPB, WGI, WFI, PØ, HØ, SØ, FARØ, WF, WGT, WFT, HV)

PI, PØ - A/B Inlet and Exit Total Pressures (Units In Atmospheres)

TØ - A/B Exit Total Temperature

HI, HØ - Enthalpy

FARI, FARØ - A/B Inlet and Exit Fuel to Air Ratios

ETA - A/B Combustion Efficiency (i.e., Applied to Heating Value of Fuel)

DPB - Total Pressure Drop Across Afterburner

WGI, WGT	- A/B Inlet and Exit Mass Flows
WFI, WF, WFT	- Main Combustor, A/B, and Total Fuel Flows at A/B Station
SØ	- A/B Exit Entropy
HV	- Heating Value of Fuel (JP-4)

Subroutines Required: THERMØ, PRØCØM, AFQUIR.

NØZ:

Routine for calculating fully expanded, isentropic nozzle conditions.

CALL NOZ (PI, PTI, TTI, STI, FARI, TSØ, HSØ)

PI	- Ambient Pressure to Which Mass Flow Expands (Units In Atmospheres)
PTI	- Total Pressure Into Nozzle (Units In Atmospheres)
TTI	- Total Temperature Into Nozzle
STI	- Total Entropy Into Nozzle
FARI	- Total Fuel to Air Ratio Into Nozzle
TSØ, HSØ	- Static Temperature and Enthalpy Out of Nozzle

Subroutines Required: THERMØ, PRØCØM.

ATMØS:

Routine that simulates 1962 U.S. Standard Atmosphere.

See program listing for calling sequence and definitions of parameters.

PRØCØM:

Routine that calculates the thermodynamic properties of air and fuel/air mixtures. Range of temperatures is 300 - 4000°R, Range of fuel/air ratio is 0 - 0.067623 (Stoichiometric). Dissociation is not accounted for in this routine.

Calling sequence:

CALL PRØCØM (FAR, T, CS, AK, CP, R, PHI, H)

FAR	- Fuel to Air Ratio
T	- Temperature
CS	- Speed of Sound
AK	- Ratio of Specific Heats (GAMMA)
CP	- Specific Heat At Constant Pressure
R	- Gas Constant
PHI	- ϕ
H	- Enthalpy

THERMØ:

Routine that adds more flexibility in using PRØCØM.

Calling sequence:

CALL THERMØ (P, H, T, S, AM, L, FAR, K)

P	- Pressure In Atmospheres
H	- Enthalpy
T	- Temperature
S	- Entropy
AM	- Molecular Weight of Mass

L	- Fuel to Air Ratio Indicator
	0 = 100% Air
	1 = Fuel to Air Ratio = FAR
FAR	- Fuel to Air Ratio
K	- Indicates Solution Desired for T or S
	0 = Find H for Input T
	1 = Find T for Input H

Subroutine Required: PRØCØM.

AFQUIR:

Air Force Quadratic Interpolation Routine. This routine sets up a quadratic equation and coverages on a solution using Newton's method of solving equations.

See program listing for calling sequence and definitions of parameters.

SECTION IV

INPUT PARAMETERS

SYMBOL	INITIAL VALUE	DESCRIPTION
ALTP	0.0	Altitude
AM	0.0	Flight Mach No.
ETAR	0.0	Ram Recovery
		= 0.0, calculates Mil Spec., otherwise uses value input
DELTO	0.0	Change in ambient temp from 1962 atmosphere
P2	0.0	Engine face pressure in atmospheres
		Input only if different from that calculated by ETAR
PRES	1.0	= 1.0 Prints output pressures in atmospheres
		= 14.696 Prints output pressures in lbs/sq inch
WAENG	1.0	Total engine inlet airflow
BPR	0.0	Bypass ratio = duct flow/core flow
		= 0.0, turbojet (i.e., no duct)
CV	1.0	Nozzle velocity coefficient = actual/ideal velocity
DPD	0.0	Duct pressure loss, (P24-P26)/P24
DPFH	0.0	Fan hub pressure loss, (P21H - P21L)/P21H
DPC	0.0	Inter-Compressor Pressure Loss, (P22L - P22)/P22L
PRFT	1.0	Fan tip pressure ratio
PRFH	1.0	Fan hub pressure ratio

SYMBOL	INITIAL VALUE	DESCRIPTION
PRLP	1.0	LP compressor pressure ratio
PRC	1.0	HP compressor pressure ratio
LCSL	0.0	LP compressor seal leakage, dumps into duct if turbofan or overboard if turbojet
HCSL	0.0	HP compressor seal leakage, dumps same as LCSL
ETAFT	1.0	Fan tip efficiency
ETAFH	1.0	Fan hub efficiency
ETALP	1.0	LP compressor efficiency
ETAC	1.0	HP compressor efficiency
ETATH	1.0	HP turbine efficiency
ETATL	1.0	LP turbine efficiency
T4	0.0	Combustor discharge temperature (^{o}R)
T7	0.0	A/B combustor discharge temperature (^{o}R)
T27	0.0	Duct combustor discharge temperature (^{o}R)
DPT	0.0	Inter-turbine pressure loss, (P5 - P51)/P5
DPE	0.0	Tailpipe cold pressure loss, (P56 - P6)/P56
ETAB	1.0	Main combustion efficiency
ETABAB	1.0	A/B combustion efficiency
ETABFD	1.0	Duct combustion efficiency
DPB	0.0	Main combustor pressure loss, (P3 - P4)/P3
DPBAB	0.0	A/B combustor hot pressure loss, (P6 - P7)/P6
DPBFD	0.0	Duct combustor hot pressure loss, (P26 - P27)/P26

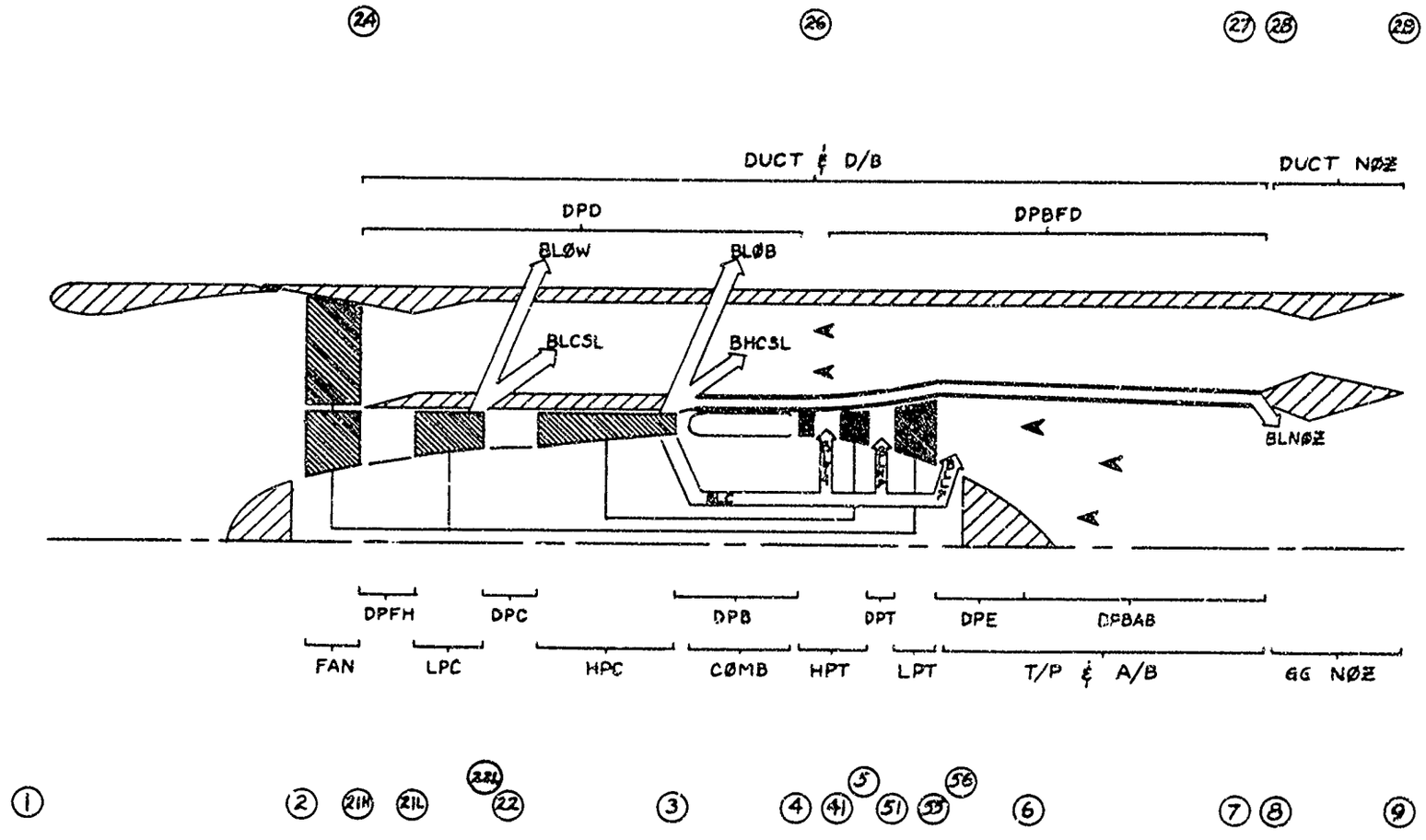
SYMBOL	INITIAL VALUE	DESCRIPTION
PCBLNZ	0.0	Engine core nozzle cooling flow ratio (to HP compressor inlet flow)
PCBLØW	0.0	LP compressor bleed flow ratio (to LP compressor inlet flow). Lost to cycle.
PCBLØB	0.0	HP compressor bleed flow ratio (to HP compressor inlet flow). Lost to cycle.
PCBLC	0.0	Turbine cooling bleed flow ratio extracted from HP compressor (to HP compressor inlet flow)
PCBLT4	0.0	HP turbine inlet nozzle cooling flow ratio (to HP compressor inlet flow)
PCBLHP	0.0	HP turbine exit cooling flow ratio (to HP compressor inlet flow).
HPEXT	0.0	Horsepower extracted from HP turbine for accessory drive
ITITLE	0	= 1, card following data case will be title card (Col. 1 - 66). Program then sets = 0. = 0, no title card expected. The last title card read will be printed at top of output page
IDEL	0	Design "derivative" indicator. (See discussion of routines: DSDRIV)
IAFTBN	0	= 0, no A/B. = 1, use input T7 Must be set = 1 for each A/B point
IDBURN	0	= 0, no duct burning = 1, use input T27 Must be set = 1 for each duct burning point

SECTION V

STATION DESIGNATION

STATION NUMBER	LOCATION
1	Ambient
2	Inlet exit/ engine face
Core:	
21H	Fan hub discharge
21L	LP compressor inlet if PRLP is greater than 1.0, otherwise HP compressor inlet
22L	LP compressor discharge
22	HP compressor inlet
3	HP compressor discharge
4	Main combustor discharge
41	HP turbine inlet
5	HP turbine discharge before cooling flow has been added
51	LP turbine inlet
55	LP turbine discharge before cooling flow has been added
56	LP turbine discharge including cooling flow effects
6	A/B combustor inlet
7	A/B combustor discharge
8	Engine core nozzle inlet
9	Engine core nozzle discharge (Isentropic expansion to P1)
Duct:	
24	Fan tip discharge

STATION NUMBER	LOCATION
26	Duct burner inlet
27	Duct burner discharge
28	Duct nozzle inlet
29	Duct nozzle discharge (Isentropic expansion to P1)



Station Designation Schematic

SECTION VI

OUTPUT PARAMETERS

Besides most of the input parameters being output, the following parameters are also output.

SYMBOL	UNITS	DESCRIPTION
VA	fps	Flight velocity
CS	fps	Ambient speed of sound
PCBLLP	---	LP turbine exit cooling flow ratio (to HP compressor inlet flow)
	NOTE:	PCBLC = PCBLT4 + PCBLHP + PCBLLP
PRØA	---	Overall core compression ratio, (P3/ P2)
WA--	#/ sec	Airflow rate (number designates location)
BLCSL	#/ sec	LP compressor seal leakage flow rate
BHCSL	#/ sec	HP compressor seal leakage flow rate
P-	Atmospheres or psi	Total pressure (number designates location)
T-	^{o}R	Total temperature (number designates location)
PRTH	---	HP turbine pressure ratio, (P41/ P5)
PRTL	---	LP turbine pressure ratio, (P51/ P55)
BLNØZ	#/ sec	Engine core nozzle cooling flow
V9, V29	fps	Nczzle exit velocities (Isentropic expansion to P1)
HV		Main combustor fuel heating value at T4 for JP-4

SYMBOL	UNITS	DESCRIPTION
HV7, HV27		A/B and duct burner fuel heating values at their respective temperatures for JP-4
FN/WA	---	Net thrust/total engine airflow
THG9	---	Core gross thrust per pound total airflow
THG29	---	Duct gross thrust per pound total airflow
ETAP	---	Propulsion Efficiency
H-	BTU/# Mass	Total enthalpy (number designates location)
TS9, TS29	^{o}R	Static temperature at nozzle exits
HS9, HS29	BTU/# Mass	Static enthalpy at nozzle exits
BLØW	#/sec	LP compressor bleed flow lost to cycle
BLØB	#/sec	HP compressor bleed flow lost to cycle
BLC	#/sec	HP compressor bleed flow for turbine cooling
BLT4	#/sec	HP turbine inlet nozzle cooling flow
BLHP	#/sec	HP turbine discharge cooling flow
BLLP	#/sec	LP turbine discharge cooling flow
	NOTE:	BLC = BLT4 + BLHP + BLLP
WG-	#/sec	Mass flow rate (includes fuel flow)
FAR-	---	Fuel flow/airflow (number designates location)

SYMBOL	UNITS	DESCRIPTION
WF-	#/sec	Fuel flow rate (number designates combustor location)
ETATHM	---	Thermal Efficiency
ETAØ	---	Overall efficiency (i.e., ETAP x ETATHM)
SFCU	# fuel per hr/# net thrust	Uninstalled specific fuel consumption
FG	# thrust	Gross thrust
FN	# thrust	Net thrust

SECTION VII

PROGRAM LISTING

```
$IBFTC CARPET  DECK
      COMMON /PARAM/  ETAR  ,ETAFT ,ETAFH ,ETALP ,ETAC  ,
     1  ETAB  ,ETATH ,ETATL ,PRFT  ,PRFH  ,PRLP  ,PRC   ,
     2  DPB   ,DPT   ,DPE   ,DPD   ,DPFH  ,DPC   ,HPEXT ,
     3  LCSL  ,HCSL  ,PCBLNZ,PCBLOW,PCBLOB,PCBLC ,CV    ,
     4  T4    ,T7    ,T27   ,ETABAB,ETABFD,DPBAB ,DPBFD
      DIMENSION TITLE(11),AWORD(4)
      REAL LCSL
      DATA AWORD/6HATMOSP,6HHERES ,6HLBS/SQ,6H INCH /

      NAMELIST/ INPUT/
     1  ALTP  ,AM    ,ETAR  ,DELTO ,P2    ,PRES  ,
     2  WAENG ,BPR   ,CV    ,DPD   ,DPFH  ,DPC   ,
     3  PRFT  ,PRFH  ,PRLP  ,PRC   ,LCSL  ,HCSL  ,
     4  ETAFT ,ETAFH ,ETALP ,ETAC  ,ETATH ,ETATL ,
     5  T4    ,T7    ,T27   ,DPT   ,DPE   ,PCBLNZ,
     6  ETAB  ,ETABAB,ETABFD,PCBLOW,PCBLOB,PCBLC ,
     7  DPB   ,DPBAB ,DPBFD ,PCBLT4,PCBLHP,HPEXT ,
     8  ITITLE,IDEL  ,IAFTBN,IDBURN

      IP    =1
      PRES  =1.0
      WAENG =1.0
      CV    =1.0
      PRFT  =1.0
      PRFH  =1.0
      PRLP  =1.0
      PRC   =1.0
      ETAFT =1.0
      ETAFH =1.0
      ETALP =1.0
      ETAC  =1.0
      ETATH =1.0
      ETATL =1.0
      ETAB  =1.0
      ETABAB=1.0
      ETABFD=1.0
      DELTO =0.0
      BPR   =0.0
      DPD   =0.0
      DPFH  =0.0
      DPC   =0.0
      LCSL  =0.0
      HCSL  =0.0
      DPT   =0.0
      DPE   =0.0
      PCBLNZ=0.0
      PCBLOW=0.0
      PCBLOB=0.0
      PCBLC =0.0
      DPB   =0.0
      DPBAB =0.0
      DPBFD =0.0
      PCBLT4=0.0
      PCBLHP=0.0
      HPEXT =0.0
      IDEL  =0

C *** CONSTANTS
      G     =32.174049
```

```
      AJ    =778.26
1     P2    =0.0
      ETAR  =0.0
      IERROR=0
      IAFTBN=0
      IDBURN=0
      JBASE =0
      READ (5,INPUT)
      IF(ITITLE.GT.0) READ(5,100) (TITLE(I),I=1,11)
      ITITLE=0
      ALT   =ALTP*2.0855531E07/(2.0855531E07-ALTP)
      CALL ATMOS(ALT,T1,X1,X2,X3,P1,CS,X4,IIII
      T1    =T1+DELTO
      IF(DELTO.GT.0.0) CALL PROCOM(0.0,T1,CS,X1,X2,X3,X4,X5)
C *** BEGINNING OF INLET
      IF(ETAR.EQ.0.0) CALL RAM(AM,ETAR)
      VA    =AM*CS
      CALL THERMO(P1,H1,T1,S1,X1,0,0.0,0)
      H2    =H1+VA**2/(2.*G*AJ)
      P2P   =1.0
      DO 3 J=1,10
      CALL THERMO(P2P,H2,X1,S2P,AMW2P,0,0.0,1)
      IF(ABS(S2P-S1).LE.0.0001*S1) GO TO 5
3     P2P   =P1*EXP(.5035471*AMW2P*(S2P-S1+1.985912/AMW2P*ALOG(P2P/P1)))
      GO TO 500
5     IF(P2.GT.0.0) ETAR  =P2/P2P
      P2    =P2P*ETAR
      CALL THERMO(P2,H2,T2,S2,X1,0,0.0,1)
6     IF(IDEL.GT.0) CALL DSDRIV(1$1)
      IF(BPR.LE.0.0) GO TO 7
C *** BEGINNING OF FAN TIP
      CALL COMP(PRFT,ETAFT,P2,T2,S2,H2,P24,T24,S24,H24,IER)
      IF(IER.GT.0) GO TO 501
C *** BEGINNING OF FAN HUB
      CALL COMP(PRFH,ETAFH,P2,T2,S2,H2,P21H,T21,S21,H21,IER)
      IF(IER.GT.0) GO TO 502
      P21L  =P21H*(1.0-DPFH)
      GO TO 9
7     P24   =0.0
      T24   =0.0
      H24   =0.0
      DPD   =0.0
      PRFT  =1.0
      ETAFT =1.0
      P21H  =P2
      P21L  =P21H
      T21   =T2
      H21   =H2
      DPFH  =0.0
      PRFH  =1.0
      ETAFH =1.0
9     IF(PRLP.LE.1.0) GO TO 11
C *** BEGINNING OF LP COMPRESSOR
      CALL THERMO(P21L,H21,T21,S21,X1,0,0.0,0)
      CALL COMP(PRLP,ETALP,P21L,T21,S21,H21,P22L,T22,S22,H22,IER)
      IF(IER.GT.0) GO TO 503
```

```
      GO TO 13
11    P22L  =P21L
      T22   =T21
      H22   =H21
      DPC   =0.0
      PRLP  =1.0
      ETALP =1.0
      LCSL  =0.0
13    IF(PRC .LE.1.0) GO TO 15

C *** BEGINNING OF HP COMPRESSOR
      P22   =P22L*(1.0-DPC)
      CALL THERMO(P22,H22,T22,S22,X1,0,0.0,0)
      CALL COMP(PRC,ETAC,P22,T22,S22,H22,P3,T3,S3,H3,IER)
      IF(IER.GT.0) GO TO 504
      GO TO 17
15    P22   =P22L
      P3    =P22
      T3    =T22
      H3    =H22
      DPC   =0.0
      PRC   =1.0
      ETAC  =1.0
      HCSL  =0.0
17    PROA  =PRC*PRLP*(1.0-DPC)*PRFH*(1.0-DPFH)

C *** AIR FLOWS
      WA2   =1.0
      WA21  =WA2/(BPR+1.0)
      WA24  =WA2-WA21
      WA22  =WA21*(1.0-LCSL-PCBLOW)
      WA3   =WA22*(1.0-HCSL-PCBLOB-PCBLC-PCBLNZ)

C *** BLEED FLOWS
      BLOW  =PCBLOW*WA21
      BLLCSL=LCSL  *WA22
      BLHCSL=HCSL  *WA22
      BLOB  =PCBLOB*WA22
      IF((PCBLT4+PCBLHP).GT.PCBLC) PCBLHP=PCBLC-PCBLT4
      PCBLLP=PCBLC-PCBLT4-PCBLHP
      BLC   =PCBLC *WA22
      BLT4  =PCBLT4*WA22
      BLHP  =PCBLHP*WA22
      BLLP  =PCBLLP*WA22
      BLNOZ =PCBLNZ*WA22

C *** BEGINNING OF MAIN COMBUSTOR
      CALL COMB(P3,T4,H3,ETAB,DPB,P4,H4,S4,FAR4,HV)
      WF4   =FAR4*WA3
      WG4   =WA3+WF4

C *** BEGINNING OF HP TURBINE
      P41   =P4
      WG41  =WG4+BLT4
      FAR41 =WF4/(WA3+BLT4)
      H41   =(H4*WG4+H3*BLT4)/WG41
      CALL THERMO(P41,H41,T41,S41,X1,1,FAR41,1)
      HPBTU =0.7068*HPEXT/(WAENG*WG41)
      DHTH  =(HPBTU+(H3-H22)*WA22)/WG41
      CALL TURB(P41,H41,S41,FAR41,ETATH,DHTH,P5,T5,H5,S5,IER)
      IF(IER.GT.0) GO TO 505
```

```
      PRTH  =P41/P5
      P51   =P5*(1.0-DPT)
      WG51  =WG41+BLHP
      H51   =(H5*WG41+H3*BLHP)/WG51
      FAR51 =WF4/(WG51-WF4)
      CALL THERMO(P51,H51,T51,S51,X1,1,FAR51,1)

C *** BEGINNING OF LP TURBINE
      DHTL  =((H24-H2)*WA24+(H21-H2)*WA21+(H22-H21)*WA21)/WG51
      CALL TURB(P51,H51,S51,FAR51,ETATL,DHTL,P55,T55,H55,S55,IER)
      IF(IER.GT.0) GO TO 506
      PRTL  =P51/P55
      P56   =P55
      WG56  =WG51+BLLP
      H56   =(H55*WG51+H3*BLLP)/WG56
      FAR56 =WF4/(WG56-WF4)
      CALL THERMO(P56,H56,T56,S56,X1,1,FAR56,1)

C *** BEGINNING OF TAILPIPE AND A/B
      P6    =P56*(1.0-DPE)
      T6    =T56
      H6    =H56
      IF(IAFTBN.GT.0) GO TO 19
      WF7   =0.0
      T7    =T6
      P7    =P6
      H7    =H6
      FAR7  =FAR56
      WG7   =WG56
      WFTGG =WF4
      GO TO 21
19    CALL ABFIRE(P6,T7,H6,FAR56,ETABAB,DPBAB,WG56,WF4,P7,H7,S7,
     1  FAR7,WF7,WG7,WFTGG,HV7)

C *** BEGINNING OF GG NOZZLE
21    WG8   =WG7+BLNOZ
      H8    =(H7*WG7+H3*BLNOZ)/WG8
      FAR8  =WFTGG/(WG8-WFTGG)
      P8    =P7
      CALL THERMO(P8,H8,T8,S8,X1,1,FAR8,1)
      IF(P8.LT.P1) GO TO 507
      CALL NOZ(P1,P8,T8,S8,FAR8,TS9,HS9)
      IF(TS9.LE.T1) GO TO 508
      V9    =CV*223.733*SQRT(H8-HS9)
      IF(BPR.LE.0.0) GO TO 23

C *** BEGINNING OF DUCT AND O/B
      P26   =P24*(1.0-DPD)
      WA26  =WA24+LCSL*WA21+HCSL*WA22
      H26   =(H24*WA24+H21*LCSL*WA21+H22*HCSL*WA22)/WA26
      CALL THERMO(P26,H26,T26,S26,X1.0,0.0,1)
      IF(IDBURN.GT.0) GO TO 25
      FAR27 =0.0
      WF27  =0.0
      P27   =P26
      T27   =T26
      H27   =H26
      S27   =S26
      GO TO 27
23    P26   =0.0
      T26   =0.0
```

```
      H26    =0.0
      P27    =0.0
      T27    =0.0
      H27    =0.0
      P28    =0.0
      T28    =0.0
      H28    =0.0
      TS29   =0.0
      HS29   =0.0
      V29    =0.0
      XMU    =0.0
      WF27   =0.0
      GO TO 29
25    CALL COM8(P26,T27,H26,ETA8FD,DP8FD,P27,H27,S27,FAR27,HV27)
      WF27   =FAR27*WA26
27    WG27   =WA26+WF27
      WG28   =WG27
      P28    =P27
      T28    =T27
      H28    =H27
      S28    =S27
      FAR28  =FAR27
      CALL NOZ(P1,P28,T28,S28,FAR28,TS29,HS29)
      V29    =CV*223.733*SQRT(H28-HS29)

C *** PERFORMANCE CALCULATIONS
      XMU    =VA/V29
29    XNU    =VA/V9
      THG29  =V29*WG28/G
      THG9   =V9*WG8/G
      THGU   =THG9+THG29
      FNU    =THGU-VA*WA2/G
      FNOWA  =FNU/WA2
      WFTOT  =WFTGG+WF27
      SFCU   =WFTOT*3600./FNU
      FG     =THGU*WAENG
      FN     =FNOWA*WAENG
      ETAN   =1./XNU*(1.+FAR8-XNU)+BPR/XMU*(1.+FAR28-XMU)
      ETAD   =ETAN+0.5*((1.+FAR8)/XNU**2*(1.-XNU)**2+BPR*(1.+FAR28)
     1  /XMU**2*(1.-XMU)**2)
      ETAP   =ETAN/ETAD
      ETATHM=ETAD*VA**2/(G*AJ*(FAR8*(HV+VA**2/(2.*G*AJ))+
     1  BPR*FAR28*(HV27+VA**2/(2.*G*AJ))))
      ETAO   =ETAP*ETATHM

31    XWA24  =WA24   *WAENG
      XWA26  =WA26   *WAENG
      XWA21  =WA21   *WAENG
      XWA22  =WA22   *WAENG
      XWA3   =WA3    *WAENG
      XBLOW  =BLOW   *WAENG
      XBLCSL=BLLCSL*WAENG
      XBHCSL=BLHCSL*WAENG
      XBLOB  =BLOB   *WAENG
      XBLNOZ=BLNOZ  *WAENG
      XBLC   =BLC    *WAENG
      XBLT4  =BLT4   *WAENG
      XBLHP  =BLHP   *WAENG
      XBLLP  =BLLP   *WAENG
      XWG4   =WG4    *WAENG
      XWG41  =WG41   *WAENG
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      XWG51 =WG51   *WAENG
      XWG56 =WG56   *WAENG
      XWG7  =WG7    *WAENG
      XWG8  =WG8    *WAENG
      XWG27 =WG27   *WAENG
      XWG28 =WG28   *WAENG
      XWF4  =WF4    *WAENG
      XWF7  =WF7    *WAENG
      XWF27 =WF27   *WAENG
      XWFTGG=WFTGG  *WAENG
      XP1   =P1   *PRES
      XP2   =P2   *PRES
      XP21H =P21H*PRES
      XP21L =P21L*PRES
      XP22L =P22L*PRES
      XP22  =P22L*PRES
      XP3   =P3   *PRES
      XP4   =P4   *PRES
      XP41  =P41  *PRES
      XP5   =P5   *PRES
      XP51  =P51  *PRES
      XP55  =P55  *PRES
      XP56  =P56  *PRES
      XP6   =P6   *PRES
      XP7   =P7   *PRES
      XP8   =P8   *PRES
      XP24  =P24  *PRES
      XP26  =P26  *PRES
      XP27  =P27  *PRES
      XP28  =P28  *PRES
      IF(JBASE.LE.0) SFCB  =SFCU
      IF(JBASE.LE.0) FNB   =FN
      PCBSFC=SFCU/SFCB
      PCBFN =FN/FNB

      WRITE(6,2000) (TITLE(I),I=1,11)
      IF(IDEL.GT.0) CALL DSDOUT
      IF(IERROR.GT.0) WRITE(6,1990)
      WRITE(6,2001) ALTP  ,AM    ,VA    ,DELTO ,ETAR  ,CS
      WRITE(6,2002) HPEXT ,LCSL  ,HCSL  ,PCBLOW,PCBLOH,PCBLNZ
      WRITE(6,2003) PCBLC ,PCBLT4,PCBLHP,PCBLLP,PRDA  ,BPR   ,WAENG
      WRITE(6,2004) PRFT  ,ETAFT ,XWA24 ,XWA26 ,
     1              PRFH  ,ETAFH ,XWA21 ,XBLCSL
      WRITE(6,2005) PRLP  ,ETALP ,XWA22 ,XBHCSL,PRC   ,ETAC  ,XWA4
      IF(PRES.GT.1.0) IP=3
      WRITE(6,2006) DPD   ,DPFH  ,DPC   ,AWORD(IP)    ,AWORD(IP+1)
      WRITE(6,2007) XP1   ,T1    ,H1    ,XP2   ,T2    ,H2
      WRITE(6,2008) XP21H ,T21   ,H21   ,XP21L
      WRITE(6,2009) XP22L ,T22   ,H22   ,XBLOW ,XP22  ,XBLOB
      WRITE(6,2010) XP3   ,T3    ,H3    ,XBLC  ,
     1              XP4   ,T4    ,H4    ,XWG4
      WRITE(6,2011) DPB   ,ETAB  ,FAR4  ,XWF4  ,
     1              XP41  ,T41   ,H41   ,XBLT4
      WRITE(6,2012) XP5   ,T5    ,H5    ,XWG41 ,PRTH  ,ETATH ,DPT
      WRITE(6,2013) XP51  ,T51   ,H51   ,XBLHP ,
     1              XP55  ,T55   ,H55   ,XWG51
      WRITE(6,2014) PRTL  ,ETATL ,DPF   ,XP56  ,T56   ,H56   ,XBLLP
      WRITE(6,2015) XP6   ,T6    ,H6    ,XWG56 ,
     1              XP7   ,T7    ,H7    ,XWG7
      IF(IAFTBN.GT.0)      WRITE(6,2016) ETABAB,DPBAB ,XWF7
      WRITE(6,2017) XP8   ,T8    ,H8    ,XBLNOZ,
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     1              V9     ,TS9    ,HS9    ,XWG8
      WRITE(6,2018) XP24   ,T24    ,H24    ,XP26   ,T26    ,H26
      WRITE(6,2019) XP27   ,T27    ,H27    ,XWG27
      IF(IDBURN.GT.0)       WRITE(6,2020) ETABFD,DPBFD ,XWF27
      WRITE(6,2021) XP28   ,T28    ,H28    ,XWG28  ,V29    ,TS29   ,HS29
      WRITE(6,2022) FAR41  ,FAR51  ,FAR56  ,FAR7   ,FAR8   ,FAR27
      WRITE(6,2023) HV     ,HV7    ,HV27   ,CV     ,V9     ,V29
      WRITE(6,2024) FNGWA  ,THG9   ,THG29  ,ETAP   ,ETATHM,ETAO
      WRITE(6,2025) SFCU   ,FG     ,FN
      IF(IDEL.GT.0) WRITE(6,2026) PCBSFC,PCBFN
      WRITE(6,2050)
      IF(IDEL.GT.0) JBASE =1
      IF(IDEL.GT.0) GO TO 6
      GO TO 1

C *** ERROR STATEMENTS
500   WRITE(6,1500) P1,S1,P2P,S2P
      GO TO 600
501   WRITE(6,1501) P2,T2,PRFT,ETAFT
      GO TO 600
502   WRITE(6,1502) P2,T2,PRFH,ETAFH
      GO TO 600
503   WRITE(6,1503) P21L,T21,PRLP,ETALP
      GO TO 600
504   WRITE(6,1504) P22,T22,PRC,ETAC
      GO TO 600
505   WRITE(6,1505) P41,H41,DHTH,ETATH
      GO TO 600
506   WRITE(6,1506) P51,H51,DHTL,ETATL
      GO TO 600
507   WRITE(6,1507) P8,P1
      GO TO 600
508   WRITE(6,1508) TS9,T1
600   IERROR=1
      GO TO 31

100   FORMAT(11A6)
1500  FORMAT(1H1,25HINLET DID NOT CONVERGE - ,4E14.6)
1501  FORMAT(1H1,16HFAN TIP ERROR - ,4E14.6)
1502  FORMAT(1H1,16HFAN HUB ERROR - ,4E14.6)
1503  FORMAT(1H1,16HLO COMP ERROR - ,4E14.6)
1504  FORMAT(1H1,16HHI COMP ERROR - ,4E14.6)
1505  FORMAT(1H1,16HHI TURB ERROR - ,4E14.6)
1506  FORMAT(1H1,16HLO TURB ERROR - ,4E14.6)
1507  FORMAT(1H1,23HGG NOZZLE PRES ERROR - ,2E14.6)
1508  FORMAT(1H1,23HGG NOZZLE TEMP ERROR - ,2E14.6)
1990  FORMAT(1H0,35X,37H****  ERROR IN FOLLOWING POINT.  ****)

2000  FORMAT(1H1/1H ,20X,11A6)
2001  FORMAT(1H0,29X,
     1  7HALTP  =,   F8.0,9H  AM    =, F8.4,9H  VA    =, F8.2,/1H ,29X,
     2  7HDELTO =,   F8.2,9H  ETAR  =, F8.5,9H  CS    =, F8.2)
2002  FORMAT(1H0,20X,
     1  7HHPEXT =,   F8.2,9H  LCSL  =, F8.5,9H  HCSL  =, F8.5,/1H ,20X,
     2  7HPCBLOW=,   F8.5,9H  PCBLOR=, F8.5,9H  PCBLN7=, F8.5)
2003  FORMAT(1H ,20X,
     A  7HPCBLC =,   F8.5,9H  PCBLT4=, F8.5,9H  PCBLHP=, F8.5,
     1  3X,7HPCBLLP=, F8.5,/1H ,20X,
     2  7HPROA  =,   F8.3,9H  BPR   =, F8.3,9H  WAENG =, F8.2)
2004  FORMAT(1H0,20X,
     A  7HPRFT  =,   F8.4,9H  ETAFT =, F8.5,9H  WA24  =, F8.3,
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     1  3X,7HWA26  =, F8.3,/1H  0X,
     2  7HPRFH  =,   F8.4,9H  ETAFH =, F8.5,9H  WA21  =, F8.3,
     3  3X,7HBLLCSL=, F8.3)
2005 FORMAT(1H ,20X,
     A  7HPRLP  =,   F8.4,9H  ETALP =, F8.5,9H  WA22  =, F8.3,
     1  3X,7HBLHCSL=, F8.3,/1H ,20X,
     2  7HPRC   =,   F8.4,9H  ETAC  =, F8.5,9H  WA3   =, F8.3)
2006 FORMAT(1H ,20X,
     1  7HDPD   =,   F8.5,9H  DPFH  =, F8.5,9H  DPC   =, F8.5,/1H0,20X,
     2  13HPRESSURES IN ,2A6)
2007 FORMAT(1H ,20X,
     1  7HP1    =,   F8.3,9H  T1    =, F8.2,9H  H1    =, F8.2,/1H ,20X,
     2  7HP2    =,   F8.3,9H  T2    =, F8.2,9H  H2    =, F8.2)
2008 FORMAT(1H ,20X,
     1  7HP21H  =,   F8.3,9H  T21   =, F8.2,9H  H21   =, F8.2,/1H ,20X,
     2  7HP21L  =,   F8.3)
2009 FORMAT(1H ,20X,
     A  7HP22L  =,   F8.3,9H  T22   =, F8.2,9H  H22   =, F8.2,
     1  3X,7HBLOW  =, F8.3,/1H ,20X,
     2  7HP22   =,   F8.3,35X          ,9H  BLOB  =, F8.3)
2010 FORMAT(1H ,20X,
     A  7HP3    =,   F8.3,9H  T3    =, F8.2,9H  H3    =, F8.2,
     1  3X,7HBLC   =, F8.3,/1H ,20X,
     2  7HP4    =,   F8.3,9H  T4    =, F8.2,9H  H4    =, F8.2,
     3  3X,7HWG4   =, F8.3)
2011 FORMAT(1H ,20X,
     A  7HDPB   =,   F8.4,9H  ETAB  =, F8.5,9H  FAR4  =, F8.5,
     1  3X,7HWF4   =, F8.4,/1H ,20X,
     2  7HP41   =,   F8.3,9H  T41   =, F8.2,9H  H41   =, F8.2,
     3  3X,7HBLT4  =, F8.3)
2012 FORMAT(1H ,20X,
     A  7HP5    =,   F8.3,9H  T5    =, F8.2,9H  H5    =, F8.2,
     1  3X,7HWG41  =, F8.3,/1H ,20X,
     2  7HPRTH  =,   F8.4,9H  ETATH =, F8.5,9H  DPT   =, F8.5)
2013 FORMAT(1H ,20X,
     A  7HP51   =,   F8.3,9H  T51   =, F8.2,9H  H51   =, F8.2,
     1  3X,7HBLHP  =, F8.3,/1H ,20X,
     2  7HP55   =,   F8.3,9H  T55   =, F8.2,9H  H55   =, F8.2,
     3  3X,7HWG51  =, F8.3)
2014 FORMAT(1H ,20X,
     1  7HPRTL  =,   F8.4,9H  ETATL =, F8.5,9H  DPE   =, F8.5,/1H ,20X,
     2  7HP56   =,   F8.3,9H  T56   =, F8.2,9H  H56   =, F8.2,
     3  3X,7HBLLP  =, F8.3)
2015 FORMAT(1H ,20X,
     A  7HP6    =,   F8.3,9H  T6    =, F8.2,9H  H6    =, F8.2,
     1  3X,7HWG56  =, F8.3,/1H ,20X,
     2  7HP7    =,   F8.3,9H  T7    =, F8.2,9H  H7    =, F8.2,
     3  3X,7HWG7   =, F8.3)
2016 FORMAT(1H ,21X,
     1  13H* *  A/B  * *,3X,7HETABAB=, F8.5,9H  DPBAB =, F8.5,
     2  3X,7HWF7   =, F8.4)
2017 FORMAT(1H ,20X,
     A  7HP8    =,   F8.3,9H  T8    =, F8.2,9H  H8    =, F8.2,
     1  3X,7HBLNOZ =, F8.3,/1H ,20X,
     2  7HV9    =,   F8.2,9H  TS9   =, F8.2,9H  HS9   =, F8.2,
     3  3X,7HWG8   =, F8.3)
2018 FORMAT(1HO,20X,
     1  7HP24   =,   F8.3,9H  T24   =, F8.2,9H  H24   =, F8.2,/1H ,20X,
     2  7HP26   =,   F8.3,9H  T26   =, F8.2,9H  H26   =, F8.2)
2019 FORMAT(1H ,20X,
     1  7HP27   =,   F8.3,9H  T27   =, F8.2,9H  H27   =  F8.2,
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     2  3X,7HWG27  =, F8.3)
2020  FORMAT(1H ,21X,
     1  13H* *  D/B  * *,3X,7HETABFD=, F8.5,9H  DPBFD =, F8.5,
     2  3X,7HWF27  =, F8.4)
2021  FORMAT(1H ,20X,
     A  7HP28   =,   F8.3,9H  T28   =, F8.2,9H  H28   =, F8.2,
     1  3X,7HWG28  =, F8.3,/1H ,20X,
     2  7HV29   =,   F8.2,9H  TS29  =, F8.2,9H  HS29  =, F8.2)
2022  FORMAT(1HO,20X,
     1  7HFAR41 =,   F8.5,9H  FAR51 =, F8.5,9H  FAR56 =, F8.5,/1H ,20X,
     2  7HFAR7  =,   F8.5,9H  FAR8  =, F8.5,9H  FAR27 =, F8.5)
2023  FORMAT(1H ,20X,
     1  7HHV    =,   F8.1,9H  HV7   =, F8.1,9H  HV27  =, F8.1,/1H ,20X,
     2  7HCV    =,   F8.5,9H  V9    =, F8.2,9H  V29   =, F8.2)
2024  FORMAT(1HO,29X,
     1  7HFN/WA =,   F8.3,9H  THG9  =, F8.3,9H  THG29 =, F8.3,/1H ,29X,
     2  7HETAP  =,   F8.5,9H  ETATHM=, F8.5,9H  ETAO  =, F8.5)
2025  FORMAT(1H ,29X,
     1  7HSFCU  =,   F8.5,9H  FG    =, F8.1,9H  FN    =, F8.1)
2026  FORMAT(1H ,29X,
     1  10HSFC/SFCB =F8.5,15X,8HFN/FN0 =F8.5)
2050  FORMAT(1HO,26X,
     1  55HTHIS PROGRAM WAS DEVELOPED BY FUTILITY AIRCRAFT, UNINC.,/,
     2  1H ,20X,17HCOMPONENTS BRANCH,27X,
     3  23HTURBINE ENGINE DIVISION,/1H ,33X,
     4  41HU.S. AIR FORCE AERO PROPULSION LABORATORY)
      END
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$IBFTC DSDRIV  DECK
      SUBROUTINE DSDRIV(*)
      DIMENSION VAR(33),PAR(33),ISAVE(33),CSAVE(33),DSAVE(33),PSAVE(33),
     1  SSAVE(33)
      COMMON /PARAM/  ETAR   ,ETAFT  ,ETAFH  ,ETALP  ,ETAC   ,
     1  ETAB   ,ETATH  ,ETATL  ,PRFT   ,PRFH   ,PRLP   ,PRC    ,
     2  DPB    ,DPT    ,DPE    ,DPD    ,DPFH   ,DPC    ,HPEXT  ,
     3  LCSL   ,HCSL   ,PCBLNZ,PCBLOW,PCBLUB,PCBLC  ,CV     ,
     4  T4     ,T7     ,T27    ,ETABAB,ETABFD,DPBAB  ,DPBFD
      DATA VAR/
     1  6HETAR   ,6HETAFT  ,6HETAFH  ,6HETALP  ,6HETAC   ,
     2  6HETAB   ,6HETATH  ,6HETATL  ,6HPRFT   ,6HPRFH   ,6HPRLP   ,6HPRC    ,
     3  6HDPB    ,6HDPT    ,6HDPE    ,6HDPD    ,6HDPFH   ,6HDPC    ,6HHPEXT  ,
     4  6HLCSL   ,6HHCSL   ,6HPCBLNZ,6HPCBLOW,6HPCBLUB,6HPCBLC  ,6HCV     ,
     5  6HT4     ,6HT7     ,6HT27    ,6HETABAB,6HETABFD,6HDPBAB  ,6HDPBFD /
      DATA IBASE,NUM,WORD,GOON,HOWD/0,0,6H      ,6HGOON  ,6HDELTA /
      DATA AMINUS,PLUS/6HMINUS ,6HPLUS  /
      EQUIVALENCE (PAR,ETAR)
      IF(IBASE.GT.0) GO TO 1
      IBASE=1
      MUN=0
      RETURN
1     IF(WORD.EQ.GOON) GO TO 6
      IF(IBASE.GT.1) GO TO 4
      IBASE=2
      READ(5,100) WORD,HOW,COW,SOW
      IF(WORD.EQ.GOON) GO TO 7
      DO 2 I=1,33
      II=I
2     IF(WORD.EQ.VAR(I)) GO TO 3
      WRITE(6,101) WORD
      STOP
3     IF(HOW.EQ.HOWD) DELTA=COW
      IF(HOW.NE.HOWD) DELTA=COW*PAR(II)
      PERCNT=100.*DELTA/PAR(II)
      NUM=NUM+1
      ISAVE(NUM)=II
      CSAVE(NUM)=COW
      DSAVE(NUM)=DELTA
      PSAVE(NUM)=PERCNT
      SSAVE(NUM)=SOW
      PARSAV=PAR(II)
      IF(SOW.EQ.AMINUS) GO TO 4
      PAR(II)=PARSAV+DELTA
      RETURN
4     IF(IBASE.GT.2 .OR. SOW.EQ.PLUS) GO TO 5
      IBASE=3
      PAR(II)=PARSAV-DELTA
      RETURN
5     PAR(II)=PARSAV
      IBASE=1
      GO TO 1
6     IF(IBASE.GT.1) GO TO 4
      IBASE=2
      MUN=MUN+1
      IF(MUN.GT.NUM) GO TO 7
      II     =ISAVE(MUN)
      COW    =CSAVE(MUN)
      DELTA  =DSAVE(MUN)
      PERCNT=PSAVE(MUN)
      SOW    =SSAVE(MUN)
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      PARSAV=PAR(II)
      IF(SOW.EQ.AMINUS) GO TO 4
      PAR(II)=PARSAV+DELTA
      RETURN
7     IBASE=0
      RETURN1
      ENTRY DSDOUT
      IF(IBASE.EQ.1) WRITE(6,200)
      IF(IBASE.EQ.2) WRITE(6,201) VAR(II),PERCNT,DELTA
      IF(IBASE.EQ.3) WRITE(6,202) VAR(II),PERCNT,DELTA
      RETURN
100   FORMAT(A6,4X,A6,4X,E10.0,A6)
101   FORMAT(1HO,/,1HO,A6,32H NOT IN COMMON, POINT TERMINATED)
200   FORMAT(1H ,48X,10HBASE POINT)
201   FORMAT(1H ,22X,21HBASE POINT - VARYING ,A6,5H BY +,
     1  F6.1,17H PERCENT (DELTA =,F7.3,1H))
202   FORMAT(1H ,22X,21HBASE POINT - VARYING ,A6,5H BY -,
     1  F6.1,17H PERCENT (DELTA =,F7.3,1H))
      END


$IBFTC RAM     DECK
      SUBROUTINE RAM(AX,ETX)
      ETX=1.0
      IF(AX.GT.1.0) ETX=1.0-0.075*((AX-1.0)**1.35)
      IF(AX.GT.5.0) ETX=800.0/((AX**4)+935.0)
      RETURN
      END


$IBFTC COMP    DECK
      SUBROUTINE COMP(PRC,ETAC,PIN,TIN,SIN,HIN,POUT,TOUT,SOUT,HOUT,IER)
      POUT=PRC*PIN
      TOUTP=(PRC**.28572)*TIN
      DO 1 J=1,10
      CALL THERMO(POUT,HOUTP,TOUTP,SOUTP,X,0,X,0)
      IF(ABS(SOUTP-SIN).LT.0.0001*SIN) GO TO 2
1     TOUTP=TOUTP/EXP((SOUTP-SIN)*4.)
      IER=1
      RETURN
2     HOUT=((HOUTP-HIN)/ETAC)+HIN
      CALL THERMO(POUT,HOUT,TOUT,SOUT,X,0,X,1)
      IER=0
      RETURN
      END
```

```
$IBFTC COMB    DECK
      SUBROUTINE COMB(PIN,TOUT,HIN,ETAB,DPB,POUT,HOUT,SOUT,FAROUT,HV)
      DIMENSION X(9)
      X(2)=0.0
      X(3)=0.0
      POUT=PIN*(1.0-DPB)
      HV=((((((-.4594317E-19*TOUT)-.2034116E-15)*TOUT+.2783643E-11)*TOUT
     1  +.2051501E-07)*TOUT-.2453116E-03)*TOUT-.9433296E-01)*TOUT+
     2  .1845537E+05
      CALL THERMO(POUT,HOUTA,TOUT,X1,X2,0,0.,0)
      FAROUT=(HOUTA-HIN)/(HV*ETAB)
      FARS=FAROUT
      CALL THERMO(POUT,HOUT,TOUT,SOUT,X1,1,FAROUT,0)
1     DELFAR=(FARS-FAROUT)/FAROUT
      CALL AFQUIR(X(1),TOUT,DELFAR,0.,15.,.0001,.95,TNEW,ICON)
      GO TO (2,4,3),ICON
2     TOUT=TNEW
      HV=((((((-.4594317E-19*TOUT)-.2034116E-15)*TOUT+.2783643E-11)*TOUT
     1  +.2051501E-07)*TOUT-.2453116E-03)*TOUT-.9433296E-01)*TOUT+
     2  .1845537E+05
      CALL THERMO(POUT,HOUTA,TOUT,X1,X2,0,0.,0)
      FARS=(HOUTA-HIN)/(HV*ETAB)
      GO TO 1
3     WRITE(6,100)
4     CALL THERMO(POUT,HOUT,TOUT,SOUT,X1,1,FAROUT,0)
      RETURN
100   FORMAT(38H STOICHIOMETRIC TEMP WILL NOT CONVERGE)
      END

$IBFTC TURB    DECK
      SUBROUTINE TURB(PIN,HIN,SIN,FARIN,ETATIN,DHTIN,POUT,TOUT,
     1  HOUT,SOUT,IER)
      HOUT =HIN-DHTIN
      HOUTP=HIN-DHTIN/ETATIN
      POUT =PIN*.5
      DO 1 J=1,10
      CALL THERMO(POUT,HOUTP,TOUT,SOUT,AMOUT,1,FARIN,1)
      IF(ABS(SOUT-SIN).LT.0.0001*SIN) GO TO 2
1     POUT =PIN*EXP((.5035471*AMOUT)*((SOUT-SIN)+(1.985912/AMOUT)
     1*ALOG(POUT/PIN)))
      IER=1
      RETURN
2     CALL THERMO(POUT,HOUT,TOUT,SOUT,X,1,FARIN,1)
      IER=0
      RETURN
      END
```

```
$IBFTC ABFIRE  DECK
      SUBROUTINE ABFIRE(PIN,TOUT,HIN,FARIN,ETAB,DPB,WGIN,WFIN,POUT,HOUT,
     1  SOUT,FAROUT,WF,WGTOT,WFTOT,HV)
      DIMENSION X(9)
      X(2)=0.0
      X(3)=0.0
      POUT=PIN*(1.0-DPB)
      CALL THERMO(POUT,HOUTA,TOUT,X1,X2,1,FARIN,0)
      HV=((((((-.4594317E-19*TOUT)-.2034116E-15)*TOUT+.2783643E-11)*TOUT
     1  +.2051501E-07)*TOUT-.2453116E-03)*TOUT-.9433296E-01)*TOUT+
     2  .1845537E+05
      FARX=(HOUTA-HIN)/(HV*ETAB)
      WF=FARX*WGIN
      WGTOT=WF+WGIN
      WFTOT=WF+WFIN
      FAROUT=WFTOT/(WGIN-WFIN)
      FARS=FAROUT
      CALL THERMO(POUT,HOUT,TOUT,SOUT,X1,1,FAROUT,0)
1     DELFAR=(FARS-FAROUT)/FAROUT
      CALL AFQUIR(X(1),TOUT,DELFAR,0.,15.,.0001,0.95,TNEW,ICON)
      GO TO (2,4,3),ICON
2     TOUT=TNEW
      HV=((((((-.4594317E-19*TOUT)-.2034116E-15)*TOUT+.2783643E-11)*TOUT
     1  +.2051501E-07)*TOUT-.2453116E-03)*TOUT-.9433296E-01)*TOUT+
     2  .1845537E+05
      CALL THERMO(POUT,HOUTA,TOUT,X1,X2,0,0.,0)
      FARX=(HOUTA-HIN)/(HV*ETAB)
      WF=FARX*WGIN
      WGTOT=WF+WGIN
      WFTOT=WF+WFIN
      FARS=WFTOT/(WGIN-WFIN)
      GO TO 1
3     WRITE(6,100)
4     CALL THERMO(POUT,HOUT,TOUT,SOUT,X1,1,FAROUT,0)
      RETURN
100   FORMAT(47H ABFIRE - STOICHIOMETRIC TEMP WILL NOT CONVERGE)
      END


$IBFTC NOZ     DECK
      SUBROUTINE NOZ(P1,PTIN,TTIN,STIN,FARIN,TSOUT,HSOUT)
      TSOUT=TTIN*((P1/PTIN)**.286)
      DO 1 J=1,10
      IF(TSOUT.LT.300.0) TSOUT=300.0
      CALL THERMO(P1,HSOUT,TSOUT,SSOUT,2,1,FARIN,0)
      IF(ABS(SSOUT-STIN).LT.0.0001*STIN) GO TO 2
1     TSOUT=TSOUT/(EXP((SSOUT-STIN)*4.))
      WRITE(6,100) P1,TTIN,TSOUT
2     RETURN
100   FORMAT(29H NOZZLE DID NOT CONVERGE, P1=,E15.6,7H, TTIN=,E15.6,
     1  8H, TSOUT=,E15.6)
      END
```

```
$IBFTC ATM062  DECK
      SUBROUTINE ATMOS (ZFT, TM, SIGMA, RHO, THETA, DELTA, CA, AMU, K)
C     THIS IS A SUBROUTINE TO COMPUTE CERTAIN ELEMENTS OF THE 1962
C     U.S. STANDARD ATMOSPHERE UP TO 90 KILOMETERS.
C      CALLING SEQUENCE...
C
C      CALL ATMOS (ZFT, TM, SIGMA, RHO, THETA, DELTA, CA, AMU, K)
C           ZFT   =   GEOMETRIC ALTITUDE (FEET)
C           TM    =   MOLECULAR SCALE TEMPERATURE (DEGREES RANKINE)
C           SIGMA =   RATIO OF DENSITY TO THAT AT SEA LEVEL
C           RHO   =   DENSITY (LB-SEC**2-FT**(-4)   OR   SLUGS-FT**3)
C           THETA =   RATIO OF TEMPERATURE TO THAT AT SEA LEVEL
C           DELTA =   RATIO OF PRESSURE TO THAT AT SEA LEVEL
C           CA    =   SPEED OF SOUND (FT/SEC)
C           AMU   =   VISCOSITY COEFFICIENT (LB-SEC/FT**2)
C
C           K = 1 NORMAL
C             = 2 ALTITUDE LESS THAN -5000 METERS OR GREATER THAN 90 KM
C             = 3 FLOATING POINT OVERFLOW
C
C     ALL DATA AND FUNDAMENTAL CONSTANTS ARE IN THE METRIC SYSTEM AS
C     THESE QUANTITIES ARE DEFINED AS EXACT IN THIS SYSTEM.
C
C     THE RADIUS OF THE EARTH (REFT59) IS THE VALUE ASSOCIATED WITH THE
C     1959 ARDC ATMOSPHERE SO THAT PROGRAMS CURRENTLY USING THE LIBRARY
C     ROUTINE WILL NOT REQUIRE ALTERATION TO USE THIS ROUTINE.
      DIMENSION HB(10),TMB(10),DELTAB(10),ALM(10)
      DATA(HB(I),    TMB(I),    DELTAB(I),     ALM(I),I=1,10)/
     A    -5.0,      320.65,    1.75363E 00,   -6.5,
     B     0.0,      288.15,    1.00000E 00,   -6.5,
     C    11.0,      216.65,    2.23361E-01,    0.0,
     D    20.0,      216.65,    5.40328E-02,    1.0,
     E    32.0,      228.65,    8.56663E-03,    2.8,
     F    47.0,      270.65,    1.09455E-03,    0.0,
     G    52.0,      270.65,    5.82289E-04,   -2.0,
     H    61.0,      252.65,    1.79718E-04,   -4.0,
     I    79.0,      180.65,    1.0241 E-05,    0.0,
     J    88.743,    180.65,    1.6223 E-06,    0.0/
      DATA  REFT59/2.0855531E 07/, GZ    /9.80665/,
     A      AMZ   /28.9644      /, RSTAR /8.31432/,
     B      FTTOKM/3.048E-04    /, S     /110.4  /,
     C      AMUZ  /1.2024E-05   /, CAZ   /1116.45/,
     D      RHOZ  /0.076474     /, GZENG /32.1741/
C  CONVERT GEOMETRIC ALTITUDE TO GEOPOTENTIAL ALTITUDE
      HFT = (REFT59/(REFT59+ZFT))*ZFT
C  CONVERT HFT AND ZFT TO KILOMETERS
      Z = FTTOKM*ZFT
      H = FTTOKM*HFT
      K = 1
      TMZ = TMB(2)
      IF (H.LT.-5.0.OR.Z.GT.90.0)  GO TO 16
      DO 10 M=1,10
      IF (H-HB(M)) 11,12,10
   10 CONTINUE
      GO TO 16
   11 M = M-1
   12 DELH = H-HB(M)
      IF (ALM(M).EQ.0.0)  GO TO 13
      TMK = TMB(M)+ALM(M)*DELH
C  GRADIENT IS NON ZERO, PAGE 10, EQUATION I.2.10-(3)
      DELTA = DELTAB(M)*((TMB(M)/TMK)**(GZ*AMZ/(RSTAR*ALM(M))))
```

```
      GO TO 14
   13 TMK = TMB(M)
C  GRADIENT IS ZERO, PAGE 10, EQUATION I.2.10-(4)
      DELTA = DELTAB(M)*EXP(-GZ*AMZ*DELH/(RSTAR*TMB(M)))
   14 THETA = TMK/TMZ
      SIGMA = DELTA/THETA
      ALPHA = SQRT(THETA**3)*((TMZ+S)/(TMK+S))
C  CONVERSION TO ENGLISH UNITS
      TM = 1.8*TMK
      RHO = RHOZ*SIGMA/GZENG
      CA = CAZ*SQRT(THETA)
      AMU = AMUZ*ALPHA/GZENG
      CALL OVERFL(J)
      GO TO (15,17), J
   15 K = K+2
      GO TO 17
   16 K = 2
   17 RETURN
      END
```

```
$IBFTC PROCOM  DECK
      SUBROUTINE PROCOM(FARX,TEX,CSEX,AKEX,CPEX,REX,PHI,HEX)
      IF(FARX.LE.0.067623) GO TO 1
      FARX=0.067623
      WRITE(6,101)
1     IF(TEX.GE.300.) GO TO 2
      TEX=300.
      WRITE(6,102)
2     IF(TEX.LE.4000.) GO TO 3
      TEX=4000.
      WRITE(6,103)
3     IF(FARX.GE.0.0) GO TO 4
      FARX=0.0
      WRITE(6,104)
C     AIR PATH
4     CPA =(((((((1.0115540E-25*TEX-1.4526770E-21)*TEX
     1  +7.6215767E-18)*TEX-1.5128259E-14)*TEX-6.7178376E-12)
     2  *TEX+6.5519486E-08)*TEX-5.1536879E-05)*TEX+2.5020051E-01
      HEA=(((((((1.2644425E-26*TEX-2.0752522E-22)*TEX
     1  +1.2702630E-18)*TEX-3.0256518E-15)*TEX-1.6794594E-12)*TEX
     2  +2.1839826E-08)*TEX-2.5768440E-05)*TEX+2.5020051E-01)*TEX
     3  -1.7558886E+00
      SEA=+2.5020051E-01*ALOG(TEX)+(((((((1.4450767E-26*TEX
     1  -2.4211288E-22)*TEX+1.5243153E-18)*TEX-3.7820648E-15)*TEX
     2  -2.2392790E-12)*TEX+3.2759743E-08)*TEX-5.1576879E-05)*TEX
     3  +4.5432300E-02
      IF(FARX.LE.0.0) GO TO 5
C     FUEL/AIR PATH
      CPF =(((((((7.2678710E-25*TEX-1.3335668E-20)*TEX
     1  +1.0212913E-16)*TEX-4.2051104E-13)*TEX+9.9686793E-10)*TEX
     2  -1.3771901E-06)*TEX+1.2258630E-03)*TEX+7.3816638E-02
      HEF=(((((((9.0848388E-26*TEX-1.9050949E-21)*TEX
     1  +1.7021525E-17)*TEX-8.4102208E-14)*TEX+2.4921698E-10)*TEX
     2  -4.5906332E-07)*TEX+6.1293150E-04)*TEX+7.3816638E-02)
     3  *TEX+3.0581530E+01
      SEF=+7.3816638E-02*ALOG(TEX)+((((((1.0382670E-25*TEX
     1  -2.2226118E-21)*TEX+2.0425826E-17)*TEX-1.0512776E-13)*TEX
     2  +3.3228928E-10)*TEX-6.8859505E-07)*TEX+1.2258630E-03)*TEX
     3  +6.483398E-01
5     CPEX=(CPA+FARX*CPF)/(1.+FARX)
      HEX=(HEA+FARX*HEF)/(1.+FARX)
      PHI=(SEA+FARX*SEF)/(1.+FARX)
      AMW=28.97-.946186*FARX
      REX=1.986375/AMW
      AKEX=CPEX/(CPEX-REX)
      CSEX=SQRT(AKEX*REX*TEX*25031.37)
      RETURN
101   FORMAT(1HO,64HINPUT FUEL-AIR RATIO ABOVE LIMITS, IT HAS BEEN RESET
     2 TO 0.067623)
102   FORMAT(1HO,35HPROCOM INPUT TEMPERATURE BELOW 300.)
103   FORMAT(1HO,36HPROCOM INPUT TEMPERATURE ABOVE 4000.)
104   FORMAT(1HO,38HPROCOM INPUT FUEL-AIR RATIO BELOW ZERO)
      END
```

```
$IBFTC THERMO  DECK
      SUBROUTINE THERMO(PX,HX,TX,SX,AMX,L,FAR,K)
      FX=0.
      IF(L.EQ.1) FX=FAR
      IF(K.EQ.1) GO TO 1
      CALL PROCOM(FX,TX,CS,AK,CP,R,PHI,HX)
      GO TO 3
1     TX=4.*HX
      DO 2 I=1,15
      CALL PROCOM(FX,TX,CS,AK,CP,R,PHI,H)
      DELH=HX-H
      IF(ABS(DELH).LE.0.00001*HX) GO TO 3
2     TX=TX+4.*DELH
      WRITE(6,100)
3     SX=PHI-R*ALOG(PX)
      AMX=1.986375/R
      RETURN
100   FORMAT(25HONO CONVERGENCE IN THERMO)
      END
```

```
$IBFTC AFQUIR  DECK
      SUBROUTINE AFQUIR(X,AIND,DEPEND,ANS,AJ,TOL,DIR,ANEW,ICON)
      DIMENSION X(9)
C X(1)=NAME OF ARRAY TO USE
C AIND=INDEPENDANT VARIABLE
C DEPEND= DEPENDANT VARIABLE
C ANS=ANSWER UPON WHICH TO CONVERGE
C AJ=MAX NUMBER OF TRYS
C TOL=PERCENT TOLERANCE FOR CONVERGENCE
C DIR=DIRECTION AND PERCENTAGE FOR FIRST GUESS
C ANEW=CALCULATED VALUE OF NEXT TRY AT INDEPENDANT VARIABLE
C ICON=CONTROL  =1 GO THRU LOOP AGAIN
C               =2 YOU HAVE REACHED THE ANSWER
C               =3 COUNTER HAS HIT LIMITS
C X(2)=COUNTER STORAGE
C X(3)=CHOOSES METHOD OF CONVERGENCE
C X(4)=THIRD DEPEND VAR
C X(5)=THIRD IND VAR
C X(6)=SECOND DEPEND VAR
C X(7)=SECOND IND VAR
C X(8)=FIRST DEPEND VAR
C X(9)=FIRST IND VAR
C X(3) MUST BE ZERO UPON FIRST ENTRY TO ROUTINE

      Y=0.
      IF(ANS)1,2,1
1     DEP=DEPEND-ANS
      TOLANS=TOL*ANS
      GO TO 3
2     DEP=DEPEND
      TOLANS=TOL
3     IF(ABS(DEP)-TOLANS)5,5,4
4     IF(X(2)-AJ)8,8,7
5     ANEW=AIND
      X(2)=0.
      ICON=2
      RETURN
6     ANEW=Y
      X(2)=X(2)+1.
      ICON=1
      RETURN
7     ANEW=Y
      X(2)=0.
      ICON=3
      RETURN
8     IF(X(3))9,9,12
C *** FIRST GUESS USING DIR
9     X(3)=1.
      X(8)=DEP
      X(9)=AIND
      IF(AIND)10,11,10
10    Y=DIR*AIND
      GO TO 6
11    Y=DIR
      GO TO 6
12    IF(X(3)-1.)13,13,16
C *** LINEAR GUESS
13    X(3)=2.
      X(6)=DEP
      X(7)=AIND
      IF(X(8)-X(6))14,9,14
```

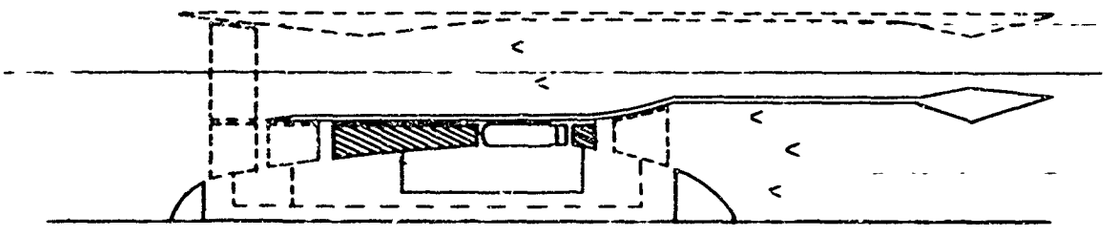
```
14      IF(X(9)-X(7))15,9,15
15      A=(X(9)-X(7))/(X(8)-X(6))
        Y=X(9)-A*X(8)
        IF(ABS(10.*X(9))-ABS(Y))9,9,6
C *** QUADRATIC GUESS
16      X(4)=DEP
        X(5)=AIND
        IF(X(7)-X(5))18,17,18
17      IF(X(6)-X(4))13,9,13
18      IF(X(6)-X(4))19,13,19
19      IF(X(9)-X(5))23,20,23
20      IF(X(8)-X(4))21,22,21
21      X(9)=X(7)
        X(8)=X(6)
        GO TO 13
22      X(9)=X(7)
        X(8)=X(6)
        X(3)=1.
        IF(X(9))10,11,10
23      IF(X(8)-X(4))24,21,24
24      F=(X(6)-X(4))/(X(7)-X(5))
        A=(X(8)-X(4)-F*(X(9)-X(5)))/((X(9)-X(7))*(X(9)-X(5)))
        B=F-A*(X(5)+X(7))
        C=X(4)+X(5)*(A*X(7)-F)
        IF(A)242,240,242
240     IF(B)241,7,241
241     Y=-C/B
        GO TO 37
242     IF(B)247,243,247
243     IF(C)245,244,245
244     Y=0.
        GO TO 37
245     G=-C/A
        IF(G)7,7,246
246     Y=SQRT(G)
        YY=-SQRT(G)
        GO TO 270
247     IF(C)249,248,249
248     Y=-B/A
        YY=0.
        GO TO 270
249     D=4.*A*C/B**2
        IF(1.-D)13,25,26
25      Y=-B/(2.*A)
        GO TO 37
26      E=SQRT(1.-D)
27      Y=(-B/(2.*A))*(1.+E)
        YY=(-B/(2.*A))*(1.-E)
270     J=4
        DEPMIN=ABS(X(4))
        DO 29 I=6,8,2
        IF(DEPMIN-ABS(X(I)))29,29,28
28      J=I
        DEPMIN=ABS(X(I))
29      CONTINUE
        K=J+1
        IF((X(K)-Y)*(X(K)-YY))32,32,30
30      IF(ABS(X(K)-Y)-ABS(X(K)-YY))37,37,31
31      Y=YY
        GO TO 37
32      IF(J-6)33,34,34
```

```
33      JJ=J+2
        KK=K+2
        GO TO 35
34      JJ=J-2
        KK=K-2
35      SLOPE=(X(KK)-X(K))/(X(JJ)-X(J))
        IF(SLOPE*X(J)*(X(K)-Y))36,36,37
36      Y=YY
37      X(9)=X(7)
        X(8)=X(6)
        X(7)=X(5)
        X(6)=X(4)
        GO TO 6
        END
```

EXAMPLE 1: SETUP OF CARPET DECK

```
$JOB            0,02,G800     68-XXX, NAME       SYMBOL
$I8JOB          NOSOURCE
$I8LDR CARPET
    .
    .
    .
    .
    .
    .
    .
$DKEND AFQUIR
$DATA
 $INPUT ALTP=0.0,AM=0.0,WAENG=115.,CV=0.985,PRC=12.5,ETAC=0.87,
 ETATH=0.89,T4=2160.,DPE=0.01,ETAB=0.98,PCBLC=0.01,DPB=0.02,
 PCBLT4=0.01,ITITLE=1$
                TURBOJET - SINGLE-SPOOL (NO A/B)
 $INPUT T4=2200.$
 $INPUT T4=2100.$
$EOF

$DATA
 $INPUT ALTP=0.0,AM=0.0,WAENG=115.,CV=0.985,PRC=12.5,ETAC=0.87,
 ETATH=0.89,T4=2160.,DPE=0.01,ETAB=0.98,PCBLC=0.01,DPB=0.02,
 PCBLT4=0.01,ITITLE=1$
                TURBOJET - SINGLE-SPOOL (NO A/B)
$EOF
```



TURBOJET - SINGLE-SPOOL (NO A/B)

ALTP	=	0.	AM	=	0.	VA	=	0.	
DELTO	=	0.	ETAR	=	1.00000	CS	=	1116.45	
HPEXT	=	0.	LCSL	=	0.	HCSL	=	0.	
PCBLOW	=	0.	PCBLOB	=	0.	PCBLNZ	=	0.	
PCBLC	=	0.01000	PCBLT4	=	0.01000	PCBLHP	=	0.	PCBLLP = 0.
PROA	=	12.500	BPR	=	0.	WAENG	=	115.00	
PRFT	=	1.0000	ETAFT	=	1.00000	WA24	=	0.	WA26 = -0.
PRFH	=	1.0000	ETAFH	=	1.00000	WA21	=	115.000	BLLCSL = 0.
PRLP	=	1.0000	ETALP	=	1.00000	WA22	=	115.000	BLHCSL = 0.
PRC	=	12.5000	ETAC	=	0.87000	WA3	=	113.850	
DPD	=	0.	DPFH	=	0.	DPC	=	0.	

PRESSURES IN ATMOSPHERES

P1	=	1.000	T1	=	518.67	H1	=	123.92	
P2	=	1.000	T2	=	518.67	H2	=	123.92	
P21H	=	1.000	T21	=	518.67	H21	=	123.92	
P21L	=	1.000							
P22L	=	1.000	T22	=	518.67	H22	=	123.92	BLOW = 0.
P22	=	1.000							BLOB = 0.
P3	=	12.500	T3	=	1135.75	H3	=	274.91	BLC = 1.150
P4	=	12.250	T4	=	2160.00	H4	=	560.29	WG4 = 115.686
DPB	=	0.0200	ETAB	=	0.98000	FAR4	=	0.01612	WF4 = 1.8355
P41	=	12.250	T41	=	2150.64	H41	=	557.48	BLT4 = 1.150
P5	=	3.264	T5	=	1623.58	H5	=	408.86	WG41 = 116.836
PRTH	=	3.7526	ETATH	=	0.89000	DPT	=	0.	
P51	=	3.264	T51	=	1623.58	H51	=	408.86	BLHP = 0.
P55	=	3.265	T55	=	1623.58	H55	=	408.86	WG51 = 116.836
PRTL	=	0.9998	ETATL	=	1.00000	DPE	=	0.01000	
P56	=	3.265	T56	=	1623.58	H56	=	408.86	BLLP = 0.
P6	=	3.232	T6	=	1623.58	H6	=	408.86	WG56 = 116.836
P7	=	3.232	T7	=	1623.58	H7	=	408.86	WG7 = 116.836
P8	=	3.232	T8	=	1623.58	H8	=	408.86	BLNOZ = 0.
V9	=	2342.97	TS9	=	1201.48	HS9	=	295.82	WG8 = 116.836
P24	=	0.	T24	=	0.	H24	=	0.	
P26	=	0.	T26	=	0.	H26	=	0.	
P27	=	0.	T27	=	0.	H27	=	0.	WG27 = -0.
P28	=	0.	T28	=	0.	H28	=	0.	WG28 = -0.
V29	=	0.	TS29	=	0.	HS29	=	0.	

FAR41	=	0.01596	FAR51	=	0.01596	FAR56	=	0.01596	
FAR7	=	0.01596	FAR8	=	0.01596	FAR27	=	-0.00000	
HV	=	17360.2	HV7	=	-0.0	HV27	=	-0.0	
CV	=	0.98500	V9	=	2342.97	V29	=	0.	
FN/WA	=	73.984	THG9	=	73.984	THG29	=	-0.	
ETAP	=	0.	ETATHM	=	0.	ETAO	=	0.	
SFCU	=	0.77666	FG	=	8508.2	FN	=	8508.2	

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U.S. AIR FORCE AERO PROPULSION LABORATORY

```
$DATA
 $INPUT ALTP=0.0,AN=0.0,WAENG=115.,CV=0.985,PRC=12.5,ETAC=0.87,
 ETATH=0.89,T4=2160.,DPE=0.01,ETAB=0.98,PCBLC=0.01,DPB=0.02,
 IDEL=1,
 PCBLT4=0.01,ITITLE=1$
     DESIGN DERIVATIVE - TURBOJET - SINGLE-SPOOL (NO A/B)
ETAC        DELTA      0.01
PRC         PERCNT     0.02
CV          DELTA      0.015      PLUS
T4          DELTA      100.
GOON
$EOF
```

DESIGN DERIVATIVE - TURBOJET - SINGLE-SPOOL (NO A/B)
BASE POINT

	ALTP	=	0.	AM	=	0.	VA	=	0.
	DELTO	=	0.	ETAR	=	1.00000	CS	=	1116.45

HPEXT	=	0.	LCSL	=	0.	HCSL	=	0.	
PCBLOW	=	0.	PCBLOB	=	0.	PCBLNZ	=	0.	
PCBLC	=	0.01000	PCBLT4	=	0.01000	PCBLHP	=	0.	PCBLLP = 0.
PROA	=	12.500	BPR	=	0.	WAENG	=	115.00	
PRFT	=	1.0000	ETAFT	=	1.00000	WA24	=	0.	WA26 = -0.
PRFH	=	1.0000	ETAFH	=	1.00000	WA21	=	115.000	BLLCSL = 0.
PRLP	=	1.0000	ETALP	=	1.00000	WA22	=	115.000	BLHCSL = 0.
PRC	=	12.5000	ETAC	=	0.87000	WA3	=	113.850	/
DPD	=	0.	DPFH	=	0.	DPC	=	0.	

PRESSURES IN ATMOSPHERES

P1	=	1.000	T1	=	518.67	H1	=	123.92	
P2	=	1.000	T2	=	518.67	H2	=	123.92	
P21H	=	1.000	T21	=	518.67	H21	=	123.92	
P21L	=	1.000							
P22L	=	1.000	T22	=	518.67	H22	=	123.92	BLOW = 0.
P22	=	1.000							BLOB = 0.
P3	=	12.500	T3	=	1135.75	H3	=	274.91	BLC = 1.150
P4	=	12.250	T4	=	2160.00	H4	=	560.29	WG4 = 115.686
DPB	=	0.0200	ETAB	=	0.98000	FAR4	=	0.01612	WF4 = 1.8355
P41	=	12.250	T41	=	2150.64	H41	=	557.48	BLT4 = 1.150
P5	=	3.264	T5	=	1623.58	H5	=	408.86	WG41 = 116.836
PRTH	=	3.7526	ETATH	=	0.89000	DPT	=	0.	
P51	=	3.264	T51	=	1623.58	H51	=	408.86	BLHP = 0.
P55	=	3.265	T55	=	1623.58	H55	=	408.86	WG51 = 116.836
PRTL	=	0.9998	ETATL	=	1.00000	DPE	=	0.01000	
P56	=	3.265	T56	=	1623.58	H56	=	408.86	BLLP = 0.
P6	=	3.232	T6	=	1623.58	H6	=	408.86	WG56 = 116.836
P7	=	3.232	T7	=	1623.58	H7	=	408.86	WG7 = 116.836
P8	=	3.232	T8	=	1623.58	H8	=	408.86	BLNOZ = 0.
V9	=	2342.97	TS9	=	1201.48	HS9	=	295.82	WG8 = 116.836
P24	=	0.	T24	=	0.	H24	=	0.	
P26	=	0.	T26	=	0.	H26	=	0.	
P27	=	0.	T27	=	0.	H27	=	0.	WG27 = -0.
P28	=	0.	T28	=	0.	H28	=	0.	WG28 = -0.
V29	=	0.	TS29	=	0.	HS29	=	0.	

FAR41	=	0.01596	FAR51	=	0.01596	FAR56	=	0.01596
FAR7	=	0.01596	FAR8	=	0.01596	FAR27	=	-0.00000
HV	=	17360.2	HV7	=	-0.0	HV27	=	-0.0
CV	=	0.98500	V9	=	2342.97	V29	=	0.

FN/WA	=	73.984	THG9	=	73.984	THG29	=	-0.
ETAP	=	0.	ETATHR	=	0.	ETAO	=	0.
SFCU	=	0.77666	FG	=	8508.2	FN	=	8508.2
SFC/SFCB	=	1.00000				FN/FNB	=	1.00000

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U.S. AIR FORCE AERO PROPULSION LABORATORY

DESIGN DERIVATIVE - TURBOJET - SINGLE-SPOOL (NO A/B)
BASE POINT - VARYING ETAC BY + 1.1 PERCENT (DELTA = 0.010)

	ALTP	=	0.	AM	=	0.	VA	=	0.
	DELTO	=	0.	ETAR	=	1.00000	CS	=	1116.45
HPEXT	=	0.	LCSL	=	0.	HCSL	=	0.	
PCBLOW	=	0.	PCBLOB	=	0.	PCBLNZ	=	0.	
PCBLC	=	0.01000	PCBLT4	=	0.01000	PCBLHP	=	0.	PCBLLP = 0.
PROA	=	12.500	BPR	=	0.	WAENG	=	115.00	
PRFT	=	1.0000	ETAFT	=	1.00000	WA24	=	0.	WA26 = -0.
PRFH	=	1.0000	ETAFH	=	1.00000	WA21	=	115.000	BLLCSL = 0.
PRLP	=	1.0000	ETALP	=	1.00000	WA22	=	115.000	BLHCSL = 0.
PRC	=	12.5000	ETAC	=	0.88000	WA3	=	113.850	
DPD	=	0.	DPFH	=	0.	DPC	=	0.	

PRESSURES IN ATMOSPHERES

P1	=	1.000	T1	=	518.67	H1	=	123.92	
P2	=	1.000	T2	=	518.67	H2	=	123.92	
P21H	=	1.000	T21	=	518.67	H21	=	123.92	
P21L	=	1.000							
P22L	=	1.000	T22	=	518.67	H22	=	123.92	BLOW = 0.
P22	=	1.000							BLOB = 0.
P3	=	12.500	T3	=	1128.96	H3	=	273.19	BLC = 1.150
P4	=	12.250	T4	=	2160.00	H4	=	560.35	WG4 = 115.697
DPB	=	0.0200	ETAB	=	0.98000	FAR4	=	0.01622	WF4 = 1.8470
P41	=	12.250	T41	=	2150.58	H41	=	557.53	BLT4 = 1.150
P5	=	3.323	T5	=	1629.81	H5	=	410.61	WG41 = 116.847
PRTH	=	3.6861	ETATH	=	0.89000	DPT	=	0.	
P51	=	3.323	T51	=	1629.81	H51	=	410.61	BLHP = 0.
P55	=	3.324	T55	=	1629.81	H55	=	410.61	WG51 = 116.847
PRTL	=	0.9998	ETATL	=	1.00000	DPE	=	0.01000	
P56	=	3.324	T56	=	1629.81	H56	=	410.61	BLLP = 0.
P6	=	3.291	T6	=	1629.81	H6	=	410.61	WG56 = 116.847
P7	=	3.291	T7	=	1629.81	H7	=	410.61	WG7 = 116.847
P8	=	3.291	T8	=	1629.81	H8	=	410.61	BLNOZ = 0.
V9	=	2362.84	TS9	=	1200.73	HS9	=	295.65	WG8 = 116.847
P24	=	0.	T24	=	0.	H24	=	0.	
P26	=	0.	T26	=	0.	H26	=	0.	
P27	=	0.	T27	=	0.	H27	=	0.	WG27 = -0.
P28	=	0.	T28	=	0.	H28	=	0.	WG28 = -0.
V29	=	0.	TS29	=	0.	HS29	=	0.	

FAR41	= 0.01606	FAR51	= 0.01606	FAR56	= 0.01606
FAR7	= 0.01606	FAR8	= 0.01606	FAR27	= -0.00000
HV	= 17360.2	HV7	= -0.0	HV27	= -0.0
CV	= 0.98500	V9	= 2362.84	V29	= 0.

FN/WA	= 74.619	THG9	= 74.619	THG29	= -0.
ETAP	= 0.	ETATHR	= 0.	ETAO	= 0.
SFCU	= 0.77487	FG	= 8581.2	FN	= 8581.2
SFC/SFCB	= 0.99770			FN/FNB	= 1.00858

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U.S. AIR FORCE AERO PROPULSION LABORATORY

DESIGN DERIVATIVE - TURBOJET - SINGLE-SPOOL (NO A/B)
BASE POINT - VARYING ETAC BY - 1.1 PERCENT (DELTA = 0.010)

ALTP = 0. MF = 0. VA = 0.
DELTO = 0. ETAR = 1.00000 CS = 1116.45

HPEXT	=	0.	LCSL	=	0.	HCSL	=	0.	
PCBLOW	=	0.	PCBLOB	=	0.	PCBLNZ	=	0.	
PCBLC	=	0.01000	PCBLT4	=	0.01000	PCBLHP	=	0.	PCBLLP = 0.
PROA	=	12.500	BPR	=	0.	WAENG	=	115.00	
PRFT	=	1.0000	ETAFT	=	1.00000	WA24	=	0.	WA26 = -0.
PRFH	=	1.0000	ETAFH	=	1.00000	WA21	=	115.000	BLLCSL = 0.
PRLP	=	1.0000	ETALP	=	1.00000	WA22	=	115.000	BLHCSL = 0.
PRC	=	12.5000	ETAC	=	0.86000	WA3	=	113.850	
DPD	=	0.	DPFH	=	0.	DPC	=	0.	

PRESSURES IN ATMOSPHERES

P1	=	1.000	T1	=	518.67	H1	=	123.92	
P2	=	1.000	T2	=	518.67	H2	=	123.92	
P21H	=	1.000	T21	=	518.67	H21	=	123.92	
P21L	=	1.000							
P22L	=	1.000	T22	=	518.67	H22	=	123.92	BLOW = 0.
P22	=	1.000							BLOB = 0.
P3	=	12.500	T3	=	1142.70	H3	=	276.67	BLC = 1.150
P4	=	12.250	T4	=	2160.00	H4	=	560.22	WG4 = 115.674
DP3	=	0.0200	ETA3	=	0.98000	FAR4	=	0.01602	WF4 = 1.8238
P41	=	12.250	T41	=	2150.69	H41	=	557.43	BLT4 = 1.150
P5	=	3.205	T5	=	1617.20	H5	=	407.06	WG41 = 116.824
PRTH	=	3.8222	ETATH	=	0.89000	DPT	=	0.	
P51	=	3.205	T51	=	1617.20	H51	=	407.06	BLBP = 0.
P55	=	3.205	T55	=	1617.20	H55	=	407.06	WG51 = 116.824
PRTL	=	0.9998	ETATL	=	1.00000	DPE	=	0.01000	
P56	=	3.205	T56	=	1617.20	H56	=	407.06	BLLP = 0.
P6	=	3.173	T6	=	1617.20	H6	=	407.06	WG56 = 116.824
P7	=	3.173	T7	=	1617.20	H7	=	407.06	WG7 = 116.824
P8	=	3.173	T8	=	1617.20	H8	=	407.06	BLWOZ = 0.
V9	=	2322.44	TS9	=	1202.26	HS9	=	296.00	WG8 = 116.824
P24	=	0.	T24	=	0.	H24	=	0.	
P26	=	0.	T26	=	0.	H26	=	0.	
P27	=	0.	T27	=	0.	H27	=	0.	WG27 = -0.
P28	=	0.	T28	=	0.	H28	=	0.	WG28 = -0.
V29	=	0.	TS29	=	0.	HS29	=	0.	

FAR41	=	0.01586	FAR51	=	0.01586	FAR56	=	0.01586	
FAR7	=	0.01586	FAR8	=	0.01586	FAR27	=	-0.00000	
HV	=	17360.2	HV7	=	-0.0	HV27	=	-0.0	
CV	=	0.98500	V9	=	2322.44	V29	=	0.	

FN/DA = 73.328 THG9 = 73.328 THG29 = -0.
ETAP = 0. ETATHM = 0. ETAO = 0.
SFCO = 0.77859 FG = 8432.6 FN = 8432.6
SFC/SFCB = 1.00246 FN/FNB = 0.99114

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U.S. AIR FORCE AERO PROPULSION LABORATORY

DESIGN DERIVATIVE - TURBOJET - SINGLE-SPOOL (60 A/S)
BASE POINT - VARYING PRC BY + 2.0 PERCENT (DELTA = 0.250)

ALTP = 0. AM = 0. VA = 0.
DELTO = 0. ETAR = 1.00000 CS = 1116.45

HPEXT =	0.	LCSL =	0.	HCSL =	0.		
PCBLDW=	0.	PCBLDB=	0.	PCBLAZ=	0.		
PCBLC =	0.01000	PCBLT4=	0.01000	PCBLHP=	0.	PCBLLP=	0.
PRDA =	12.750	SPR =	0.	WAENG =	115.00		
PRFT =	1.0000	ETAFT =	1.00000	WA24 =	0.	WA26 =	-0.
PRFH =	1.0000	ETAFH =	1.00000	WA21 =	115.000	WLLCSL=	0.
PRLP =	1.0000	ETALP =	1.00000	WA22 =	115.000	WLHCSL=	0.
PRC =	12.7500	ETAC =	0.87000	WA3 =	113.550		
DPD =	0.	DPFH =	0.	DPC =	0.		

PRESSURES IN ATMOSPHERES

P1 =	1.000	T1 =	518.67	H1 =	123.92		
P2 =	1.000	T2 =	518.67	H2 =	123.92		
P21H =	1.000	T21 =	518.67	H21 =	123.92		
P21L =	1.000						
P22L =	1.000	T22 =	518.67	H22 =	123.92	WLOW =	0.
P22 =	1.000					WLOB =	0.
P3 =	12.750	T3 =	1142.29	H3 =	276.56	WLC =	1.150
P4 =	12.495	T4 =	2160.00	H4 =	560.22	WG4 =	115.674
DPB =	0.0200	ETAB =	0.98000	FAR4 =	0.01603	WF4 =	1.6245
P41 =	12.495	T41 =	2150.69	H41 =	557.43	WLT4 =	1.150
P5 =	3.273	T5 =	1617.57	H5 =	407.17	WG41 =	116.824
PRTH =	3.8181	ETATH =	0.89000	WPT =	0.		
P51 =	3.273	T51 =	1617.57	H51 =	407.17	WLHP =	0.
P55 =	3.273	T55 =	1617.58	H55 =	407.17	WG51 =	116.824
PRTL =	0.9998	ETATL =	1.00000	DPL =	0.01000		
P56 =	3.273	T56 =	1617.58	H56 =	407.17	WLLP =	0.
P6 =	3.240	T6 =	1617.58	H6 =	407.17	WG56 =	116.824
P7 =	3.240	T7 =	1617.58	H7 =	407.17	WG7 =	116.824
P8 =	3.240	T8 =	1617.58	H8 =	407.17	WLMIX =	0.
V9 =	2340.60	TS9 =	1195.96	HS9 =	294.36	WG8 =	116.824
P24 =	0.	T24 =	0.	H24 =	0.		
P26 =	0.	T26 =	0.	H26 =	0.		
P27 =	0.	T27 =	0.	H27 =	0.	WG27 =	-0.
P28 =	0.	T28 =	0.	H28 =	0.	WG26 =	-0.
V29 =	0.	TS29 =	0.	HS29 =	0.		

FAR41 =	0.01587	FAR51 =	0.01587	FAR56 =	0.01587
FAR7 =	0.01587	FAR8 =	0.01587	FAR27 =	-0.00000
HV =	17360.2	HV7 =	-0.0	HV27 =	-0.0
CV =	0.96500	V9 =	2340.60	V29 =	0.

FN/DA = 73.902 THG9 = 73.902 THG29 = -0.
ETAP = 0. ETATH = 0. ETAO = 0.
SFCO = 0.77283 FG = 8498.6 FN = 8498.6
SFC/SFCB = 0.99507 FN/FNL = 0.99389

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U.S. AIR FORCE AERO PROPULSION LABORATORY

DESIGN DERIVATIVE - TURBOJET - SINGLE-SPOOL (NO A/B)
BASE POINT - VARYING PRC BY - 2.0 PERCENT (DELTA = 0.250)

	ALTP	=	0.	AM	=	0.	VA	=	0.
	DELTO	=	0.	ETAR	=	1.00000	CS	=	1116.45
HPEXT	=	0.	LCSL	=	0.	HCSL	=	0.	
PCBLOW	=	0.	PCBLOB	=	0.	PCBLNZ	=	0.	
PCBLC	=	0.01000	PCBLT4	=	0.01000	PCBLHP	=	0.	PCBLLP = 0.
PROA	=	12.250	BPR	=	0.	WAENG	=	115.00	
PRFT	=	1.0000	ETAFT	=	1.00000	WA24	=	0.	WA26 = -0.
PRFH	=	1.0000	ETAFH	=	1.00000	WA21	=	115.000	BLLCSL = 0.
PRLP	=	1.0000	ETALP	=	1.00000	WA22	=	115.000	BLHCSL = 0.
PRC	=	12.2500	ETAC	=	0.87000	WA3	=	113.850	
DPD	=	0.	DPFH	=	0.	DPC	=	0.	

PRESSURES IN ATMOSPHERES

P1	=	1.000	T1	=	518.67	H1	=	123.92	
P2	=	1.000	T2	=	518.67	H2	=	123.92	
P21H	=	1.000	T21	=	518.67	H21	=	123.92	
P21L	=	1.000							
P22L	=	1.000	T22	=	518.67	H22	=	123.92	BLOK = 0.
P22	=	1.000							SLOB = 0.
P3	=	12.250	T3	=	1129.11	H3	=	273.23	BLC = 1.150
P4	=	12.005	T4	=	2160.00	H4	=	560.35	WG4 = 115.697
DPB	=	0.0200	ETAB	=	0.98000	FAR4	=	0.01622	WF4 = 1.8468
P41	=	12.005	T41	=	2150.58	H41	=	557.53	BLT4 = 1.150
P5	=	3.256	T5	=	1629.67	H5	=	410.57	WG41 = 116.847
PRTH	=	3.6875	ETATH	=	0.89000	DPT	=	0.	
P51	=	3.256	T51	=	1629.67	H51	=	410.57	BLHP = 0.
P55	=	3.256	T55	=	1629.67	H55	=	410.57	WG51 = 116.847
PRTL	=	0.9998	ETATL	=	1.00000	DPE	=	0.01000	
P56	=	3.256	T56	=	1629.67	H56	=	410.57	BLLP = 0.
P6	=	3.224	T6	=	1629.67	H6	=	410.57	WG56 = 116.847
P7	=	3.224	T7	=	1629.67	H7	=	410.57	WG7 = 116.847
P8	=	3.224	T8	=	1629.67	H8	=	410.57	BLNOZ = 0.
V9	=	2345.19	TS9	=	1207.14	HS9	=	297.33	WG8 = 116.847
P24	=	0.	T24	=	0.	H24	=	0.	
P26	=	0.	T26	=	0.	H26	=	0.	
P27	=	0.	T27	=	0.	H27	=	0.	WG27 = -0.
P28	=	0.	T28	=	0.	H28	=	0.	WG28 = -0.
V29	=	0.	TS29	=	0.	HS29	=	0.	
FAR41	=	0.01606	FAR51	=	0.01606	FAR56	=	0.01606	
FAR7	=	0.01606	FAR8	=	0.01606	FAR27	=	-0.00000	
HV	=	17360.2	HV7	=	-0.0	HV27	=	-0.0	
CV	=	0.98500	V9	=	2345.19	V29	=	0.	

FN/WA	=	74.061	THG9	=	74.061	THG29	= -0.
ETAP	=	0.	ETATHM	=	0.	ETAO	= 0.
SFCU	=	0.78060	FG	=	8517.0	FN	= 8517.0
SFC/SFCB	=	1.00507				FN/FNB	= 1.00104

THIS PROGRAM WAS DEVELOPED BY FUTILITY AIRCRAFT, UNINC.
COMPONENTS BRANCH TURBINE ENGINE DIVISION
U.S. AIR FORCE AERO PROPULSION LABORATORY

DESIGN DERIVATIVE - TURBOJET - SINGLE-SPOOL (NO A/B)
BASE POINT - VARYING CV BY + 1.5 PERCENT (DELTA = 0.015)

ALTP	=	0.	AM	=	0.	VA	=	0.	
DELTO	=	0.	ETAR	=	1.00000	CS	=	1116.45	
HPEXT	=	0.	LCSL	=	0.	HCSL	=	0.	
PCBLOW	=	0.	PCBLOB	=	0.	PCBLNZ	=	0.	
PCBLC	=	0.01000	PCBLT4	=	0.01000	PCBLHP	=	0.	PCBLLP = 0.
PROA	=	12.500	BPR	=	0.	WAENG	=	115.00	
PRFT	=	1.0000	ETAFT	=	1.00000	WA24	=	0.	WA26 = -0.
PRFH	=	1.0000	ETAFH	=	1.00000	WA21	=	115.000	BLLCSL = 0.
PRLP	=	1.0000	ETALP	=	1.00000	WA22	=	115.000	BLHCSL = 0.
PRC	=	12.5000	ETAC	=	0.87000	WA3	=	113.850	
DPD	=	0.	DPFH	=	0.	DPC	=	0.	

PRESSURES IN ATMOSPHERES

P1	=	1.000	T1	=	518.67	H1	=	123.92	
P2	=	1.000	T2	=	518.67	H2	=	123.92	
P21H	=	1.000	T21	=	518.67	H21	=	123.92	
P21L	=	1.000							
P22L	=	1.000	T22	=	518.67	H22	=	123.92	BLOW = 0.
P22	=	1.000							BLOB = 0.
P3	=	12.500	T3	=	1135.75	H3	=	274.91	BLC = 1.150
P4	=	12.250	T4	=	2160.00	H4	=	560.29	WG4 = 115.686
DPB	=	0.0200	ETAB	=	0.98000	FAR4	=	0.01612	WF4 = 1.8355
P41	=	12.250	T41	=	2150.64	H41	=	557.48	BLT4 = 1.150
P5	=	3.264	T5	=	1623.58	H5	=	408.86	WG41 = 116.836
PRTH	=	3.7526	ETATH	=	0.89000	DPT	=	0.	
P51	=	3.264	T51	=	1623.58	H51	=	408.86	BLHP = 0.
P55	=	3.265	T55	=	1623.58	H55	=	408.86	WG51 = 116.836
PRTL	=	0.9998	ETATL	=	1.00000	DPE	=	0.01000	
P56	=	3.265	T56	=	1623.58	H56	=	408.86	BLLP = 0.
P6	=	3.232	T6	=	1623.58	H6	=	408.86	WG56 = 116.836
P7	=	3.232	T7	=	1623.58	H7	=	408.86	WG7 = 116.836
P8	=	3.232	T8	=	1623.58	H8	=	408.86	BLNOZ = 0.
V9	=	2378.65	TS9	=	1201.48	HS9	=	295.82	WG8 = 116.836
P24	=	0.	T24	=	0.	H24	=	0.	
P26	=	0.	T26	=	0.	H26	=	0.	
P27	=	0.	T27	=	0.	H27	=	0.	WG27 = -0.
P28	=	0.	T28	=	0.	H28	=	0.	WG28 = -0.
V29	=	0.	TS29	=	0.	HS29	=	0.	

FAR41	=	0.01596	FAR51	=	0.01596	FAR56	=	0.01596	
FAR7	=	0.01596	FAR8	=	0.01596	FAR27	=	-0.00000	
HV	=	17360.2	HV7	=	-0.0	HV27	=	-0.0	
CV	=	1.00000	V9	=	2378.65	V29	=	0.	

FN/WA	=	75.111	THG9	=	75.111	THG29	=	-0.	
ETAP	=	0.	ETATHM	=	0.	ETAO	=	0.	
SFCU	=	0.76501	FG	=	8637.7	FN	=	8637.7	
SFC/SFCB	=	0.98500				FN/FNB	=	1.01523	

THIS PROGRAM WAS DEVELOPED BY FUTILITY AIRCRAFT, UNINC.
COMPONENTS BRANCH TURBINE ENGINE DIVISION
U.S. AIR FORCE AERO PROPULSION LABORATORY

```
      DESIGN DERIVATIVE - TURBOJET - SINGLE-SPOOL (NO A/B)
   BASE POINT - VARYING T4     BY +    4.6 PERCENT (DELTA =100.000)

          ALTP =      0.   AM    =  0.      VA    =     0.
          DELTO =     0.   ETAR  = 1.00000  CS    = 1116.45

HPEXT =     0.    LCSL  = 0.        HCSL  = 0.
PCBLOH= 0.        PCBLOB= 0.        PCBLNZ= 0.
PCBLC = 0.01000   PCBLT4= 0.01000   PCBLHP= 0.        PCBLLP= 0.
PROA  =  12.500   BPR   =   0.      WAENG =  415.00

PRFT  =  1.0000   ETAFT = 1.00000  WA24  =   0.      WA26  =  -0.
PRFH  =  1.0000   ETAFH = 1.00000  WA21  = 115.000   BLLCSL=   0.
PRLP  =  1.0000   ETALP = 1.00000  WA22  = 115.000   BLHCSL=   0.
PRC   = 12.5000   ETAC  = 0.87000  WA3   = 113.850
DPD   = 0.        DPFH  = 0.       DPC   = 0.

PRESSURES IN ATMOSPHERES
P1    =   1.000   T1    =  518.67  H1    =  123.92
P2    =   1.000   T2    =  518.67  H2    =  123.92
P21H  =   1.000   T21   =  518.67  H21   =  123.92
P21L  =   1.000
P22L  =   1.000   T22   =  518.67  H22   =  123.92   BLOW  =   0.
P22   =   1.000                                      BLOB  =   0.
P3    =  12.500   T3    = 1135.75  H3    =  274.91   FLC   =  1.150
P4    =  12.250   T4    = 2260.00  H4    =  590.53   WG4   = 115.883
DPB   =  0.0200   ETAB  = 0.96000  FAR4  = 0.01786   UF4   = 2.0333
P41   =  12.250   T41   = 2249.79  H41   =  587.42   BLT4  =  1.150
P5    =   3.512   T5    = 1729.95  H5    =  439.05   WG41  = 117.033
ERTH  =  3.4878   ETATH = 0.89000  DPT   = 0.
P51   =   3.512   T51   = 1729.95  H51   =  439.05   BLHP  =   0.
P55   =   3.513   T55   = 1729.96  H55   =  439.05   WG51  = 117.033
PRTL  =  0.9998   ETATL = 1.00000  DPE   = 0.01000
P56   =   3.513   T56   = 1729.96  H56   =  439.05   BLLP  =   0.
P6    =   3.478   T6    = 1729.96  H6    =  439.05   WG56  = 117.033
P7    =   3.478   T7    = 1729.96  H7    =  439.05   WG7   = 117.033
P8    =   3.478   T8    = 1729.96  H8    =  439.05   BLNOZ =   0.
V9    = 2484.42   TS9   = 1261.29  HS9   =  311.96   WG8   = 117.033

P24   =   0.      T24   =    0.    H24   =    0.
P26   =   0.      T26   =    0.    H26   =    0.
P27   =   0.      T27   =    0.    H27   =    0.      WG27  =  -0.
P28   =   0.      T28   =    0.    H28   =    0.      WG28  =  -0.
V29   =   0.      TS29  =    0.    HS29  =    0.

FAR41 = 0.01768   FAR51 = 0.01768  FAR56 = 0.01768
FAR7  = 0.01768   FAR8  = 0.01768  FAR27 =-0.00000
HV    = 17280.5   HV7   =   -0.0   HV27  =   -0.0
CV    = 0.98500   V9    = 2484.42  V29   =   0.

        FN/WA =  78.583  THG9  =  78.583  THG29 =  -0.
        ETAP  =  0.      ETATH=  0.       ETAO  =  0.
        SFCU  = 0.80996  FG    =  9037.1  FN    =  9037.1
        SFC/SFCB = 1.04288                FN/FNB = 1.06217

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COMPONENTS BRANCH                          TURBINE ENGINE DIVISION
            U.S. AIR FORCE AERO PROPULSION LABORATORY
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DESIGN DERIVATIVE - TURBOJET - SINGLE-SPOOL (NO A/B)
BASE POINT - VARYING T4 BY - 4.6 PERCENT (DELTA =100.000)

ALTP = 0. AMN = 0. VA = 0.
DELTO = 0. ETAR = 1.00000 CS = 1116.45

HPEXT	=	0.	LCSL	=	0.	HCSL	=	0.	
PCBLOW	=	0.	PCBLOB	=	0.	PCBLNZ	=	0.	
PCBLC	=	0.01000	PCBLT4	=	0.01000	PCBLHP	=	0.	PCBLLP = 0.
PRUA	=	12.500	BPR	=	0.	WAENG	=	115.00	
PRFT	=	1.0000	ETAFT	=	1.00000	WA24	=	0.	WA26 = -0.
PRFH	=	1.0000	ETAFH	=	1.00000	WA21	=	115.000	BLLCSL = 0.
PRLP	=	1.0000	ETALP	=	1.00000	WA22	=	115.000	BLHCSL = 0.
PRC	=	12.5000	ETAC	=	0.87000	WA3	=	113.850	
DPD	=	0.	DPFH	=	0.	DPC	=	0.	

PRESSURES IN ATMOSPHERES

P1	=	1.000	T1	=	518.67	H1	=	123.92	
P2	=	1.000	T2	=	518.67	H2	=	123.92	
P21H	=	1.000	T21	=	518.67	H21	=	123.92	
P21L	=	1.000							
P22L	=	1.000	T22	=	518.67	H22	=	123.92	BLOU = 0.
P22	=	1.000							BLOB = 0.
P3	=	12.500	T3	=	1135.75	H3	=	274.91	BLC = 1.150
P4	=	12.250	T4	=	2060.00	H4	=	530.45	WG4 = 115.491
DPB	=	0.0200	ETAB	=	0.98000	FAR4	=	0.01441	WF4 = 1.6411
P41	=	12.250	T41	=	2051.49	H41	=	527.93	BLT4 = 1.150
P5	=	3.007	T5	=	1516.82	H5	=	379.06	WG41 = 116.641
PRTH	=	4.0741	ETATH	=	0.89000	DPT	=	0.	
P51	=	3.007	T51	=	1516.82	H51	=	379.06	BLHP = 0.
P55	=	3.007	T55	=	1516.82	H55	=	379.06	WG51 = 116.641
PRTL	=	0.9998	ETATL	=	1.00000	DPE	=	0.01000	
P56	=	3.007	T56	=	1516.82	H56	=	379.06	BLLP = 0.
P6	=	2.977	T6	=	1516.82	H6	=	379.06	WG56 = 116.641
P7	=	2.977	T7	=	1516.82	H7	=	379.06	WG7 = 116.641
P8	=	2.977	T8	=	1516.82	H8	=	379.06	BLNOZ = 0.
V9	=	2192.59	TS9	=	1142.38	HS9	=	280.07	WG8 = 116.641
P24	=	0.	T24	=	0.	H24	=	0.	
P26	=	0.	T26	=	0.	H26	=	0.	
P27	=	0.	T27	=	0.	H27	=	0.	WG27 = -0.
P28	=	0.	T28	=	0.	H28	=	0.	WG28 = -0.
V29	=	0.	TS29	=	0.	HS29	=	0.	

FAR41	=	0.01427	FAR51	=	0.01427	FAR56	=	0.01427
FAR7	=	0.01427	FAR8	=	0.01427	FAR27	=	-0.00000
HV	=	17438.4	HV7	=	-0.0	HV27	=	-0.0
CV	=	0.98500	V9	=	2192.59	V29	=	0.

FN/WA = 69.120 THG9 = 69.120 THG29 = -0.
ETAP = 0. ETATH = 0. ETAO = 0.
SFCU = 0.74323 FG = 7948.8 FN = 7948.8
SFC/SFCB = 0.95695 FN/FNB = 0.93426

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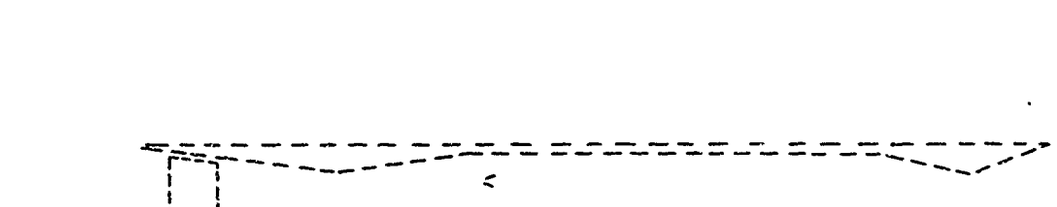
COMPONENTS BRANCH TURBINE ENGINE DIVISION
U.S. AIR FORCE AERO PROPULSION LABORATORY

```
$DATA
 $INPUT ALTP=0.0,AM=0.0,PRES=14.696,WAENG=120.,CV=0.985,
 PRLP=3.0,PRC=4.0,ETALP=0.83,ETAC=0.81,ETATH=0.88,ETATL=0.89,
 T4=2000.,DPE=0.02,ETAB=0.97,PCBLOW=0.01,PCBLC=0.0075,
 DPB=0.04,PCBLT4=0.0075,ITITLE=1$
                        TURBOJET - TWO-SPOOL
 $INPUT T4=2050.,T7=3250.,ETABAB=0.87,DPBAB=0.095,IAFTBN=1,ITITLE=1$
                TURBOJET - TWO-SPOOL (WITH A/B)
$EOF
```



TURBOJET - TWO-SPOOL

ALTP	=	0.	AM	=	0.	VA	=	0.	
DELTO	=	0.	ETAR	=	1.00000	CS	=	1116.45	
WPEXT	=	0.	LCSL	=	0.	HCSL	=	0.	
PCBLOW	=	0.01000	PCBLOB	=	0.	PCBLNZ	=	0.	
PCBLC	=	0.00750	PCBLT4	=	0.00750	PCBLHP	=	0.	PCBLLP = 0.
PROA	=	12.000	DPR	=	0.	WAENG	=	120.00	
PRFT	=	1.0000	ETAFT	=	1.00000	WA24	=	0.	WA26 = -0.
PRFH	=	1.0000	ETAFH	=	1.00000	WA21	=	120.000	BLLCSL= 0.
PRLP	=	3.0000	ETALP	=	0.83000	WA22	=	118.800	BLHCSL= 0.
PRC	=	4.0000	ETAC	=	0.81000	WA3	=	117.909	
DPD	=	0.	DPFH	=	0.	DPC	=	0.	

PRESSURES IN LBS/SQ INCH

P1	=	14.696	T1	=	518.67	H1	=	123.92			
P2	=	14.696	T2	=	518.67	H2	=	123.92			
P21H	=	14.696	T21	=	518.67	H21	=	123.92			
P21L	=	14.696									
P22L	=	44.088	T22	=	748.82	H22	=	179.28	BLOW	=	1.200
P22	=	44.088							BLOB	=	0.
P3	=	176.352	T3	=	1182.02	H3	=	286.64	BLC	=	0.891
P4	=	169.298	T4	=	2000.00	H4	=	512.41	WG4	=	119.424
DPB	=	0.0400	ETAB	=	0.97000	FAR4	=	0.01285	WF4	=	1.5151
P41	=	169.298	T41	=	1994.32	H41	=	510.73	BLT4	=	0.891
P5	=	62.783	T5	=	1613.52	H5	=	404.73	WG41	=	120.315
PRTH	=	2.6965	ETATH	=	0.88000	DPT	=	0.			
P51	=	62.783	T51	=	1613.52	H51	=	404.73	BLHP	=	0.
P55	=	34.304	T55	=	1408.84	H55	=	349.51	WG51	=	120.315
PRTL	=	1.8302	ETATL	=	0.89000	DPE	=	0.02000			
P56	=	34.304	T56	=	1408.84	H56	=	349.51	BLLP	=	0.
P6	=	33.618	T6	=	1408.84	H6	=	349.51	WG56	=	120.315
P7	=	33.618	T7	=	1408.84	H7	=	349.51	WG7	=	120.315
P8	=	33.618	T8	=	1408.84	H8	=	349.51	BLNOZ	=	0.
V9	=	1867.23	TS9	=	1134.67	HS9	=	277.72	WG8	=	120.315
P24	=	0.	T24	=	0.	H24	=	0.			
P26	=	0.	T26	=	0.	H26	=	0.			
P27	=	0.	T27	=	0.	H27	=	0.	WG27	=	-0.
P28	=	0.	T28	=	0.	H28	=	0.	WG28	=	-0.
V29	=	0.	TS29	=	0.	HS29	=	0.			

FAR41	=	0.01275	FAR51	=	0.01275	FAR56	= 0.01275
FAR7	=	0.01275	FAR8	=	0.01275	FAR27	=-0.00000
HV	=	17484.7	HV7	=	-0.0	HV27	= -0.0
CV	=	0.98500	V9	=	1867.23	V29	= 0.

FN/WA	=	58.188	THG9	=	58.188	THG29	=	-0.	
ETAP	=	0.	ETATHM	=	0.	ETAO	=	0.	
SFCO	=	0.78114	FG	=	6982.5	FN	=	6982.5	

THIS PROGRAM WAS DEVELOPED BY FUTILITY AIRCRAFT, UNINC.
COMPONENTS BRANCH TURBINE ENGINE DIVISION
U.S. AIR FORCE AERO PROPULSION LABORATORY

TURBOJET - TWO-SPOOL (WITH A/B)

ALTP = 0. AR = 0. VA = 0.
DELTO = 0. ETAR = 1.00000 CS = 1116.45

HPEXT	=	0.	LCSL	=	0.	HCSL	=	0.	
PCBLOW	=	0.01000	PCBLOB	=	0.	PCBLNZ	=	0.	
PCBLC	=	0.00750	PCBLT4	=	0.00750	PCBLHP	=	0.	PCBLLP = 0.
PROA	=	12.000	BPR	=	0.	WAENG	=	120.00	
PRFT	=	1.0000	ETAFT	=	1.00000	WA24	=	0.	WA26 = -0.
PRFH	=	1.0000	ETAFH	=	1.00000	WA21	=	120.000	BLLCSL = 0.
PRLP	=	3.0000	ETALP	=	0.83000	WA22	=	118.800	BLHCSL = 0.
PRC	=	4.0000	ETAC	=	0.81000	WA3	=	117.909	
DPD	=	0.	DPFH	=	0.	DPC	=	0.	

PRESSURES IN LBS/SQ INCH

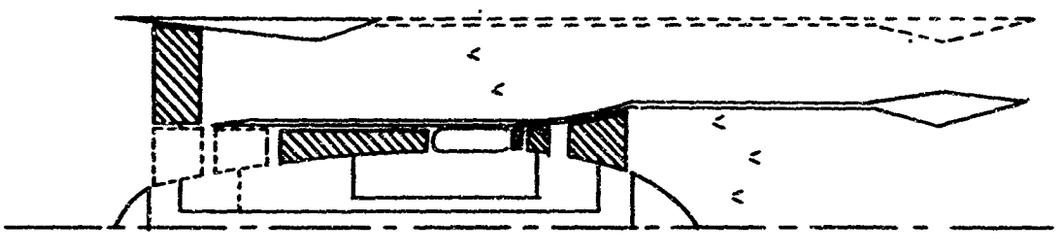
P1	=	14.696	T1	=	518.67	H1	=	123.92	
P2	=	14.696	T2	=	518.67	H2	=	123.92	
P21H	=	14.696	T21	=	518.67	H21	=	123.92	
P21L	=	14.696							
P22L	=	44.088	T22	=	748.82	H22	=	179.28	BLOW = 1.200
P22	=	44.088							BLOB = 0.
P3	=	176.352	T3	=	1182.02	H3	=	286.64	BLC = 0.891
P4	=	169.298	T4	=	2050.00	H4	=	527.14	WG4 = 119.524
DP6	=	0.0400	ETAB	=	0.97000	FAR4	=	0.01370	WF4 = 1.6152
P41	=	169.298	T41	=	2043.98	H41	=	525.37	BLT4 = 0.891
P5	=	64.625	T5	=	1665.89	H5	=	419.45	WG41 = 120.415
PRTH	=	2.6197	ETATH	=	0.88000	DPT	=	0.	
P51	=	64.625	T51	=	1665.89	H51	=	419.45	BLHP = 0.
P55	=	36.074	T55	=	1462.92	H55	=	364.28	WG51 = 120.415
PRTL	=	1.7915	ETATL	=	0.89000	DPE	=	0.02000	
P56	=	36.074	T56	=	1462.92	H56	=	364.28	BLLP = 0.
P6	=	35.352	T6	=	1462.92	H6	=	364.28	WG56 = 120.415
P7	=	31.994	T7	=	3250.00	H7	=	927.36	WG7 = 124.771
* *	A/B	* *	ETABAB	=	0.87000	DPBAB	=	0.09500	WF7 = 4.3554
P8	=	31.994	T8	=	3249.99	H8	=	927.36	BLNOZ = 0.
V9	=	2790.61	TS9	=	2751.32	HS9	=	767.01	WG8 = 124.771
P24	=	0.	T24	=	0.	H24	=	0.	
P26	=	0.	T26	=	0.	H26	=	0.	
P27	=	0.	T27	=	0.	H27	=	0.	WG27 = -0.
P28	=	0.	T28	=	0.	H28	=	0.	WG28 = -0.
V29	=	0.	TS29	=	0.	HS29	=	0.	

FAR41	=	0.01360	FAR51	=	0.01360	FAR56	=	0.01360	
FAR7	=	0.05026	FAR8	=	0.05026	FAR27	=	-0.00000	
HV	=	17446.2	HV7	=	16444.6	HV27	=	-0.0	
CV	=	0.98500	V9	=	2790.61	V29	=	0.	

FN/WA = 90.183 THG9 = 90.183 THG29 = -0.
ETAP = 0. ETATH = 0. ETAO = 0.
SFCO = 1.98617 FG = 10822.0 FN = 10822.0

THIS PROGRAM WAS DEVELOPED BY FUTILITY AIRCRAFT, UNINC.
COMPONENTS BRANCH TURBINE ENGINE DIVISION
U.S. AIR FORCE AERO PROPULSION LABORATORY

```
$DATA
 $INPUT ALTP=25000.,AM=0.75,DELTO=10.,PRES=14.696,
 WAENG=100.,BPR=2.0,CV=0.985,DPD=0.01,
 PRFT=2.5,PRC=8.0,ETAFT=0.84,ETAC=0.85,ETATH=0.90,ETATL=0.89,
 T4=2100.,DPT=0.0015,DPE=0.015,ETAB=0.985,DPB=0.02,ITITLE=1$
                TURBOFAN - AFT-FAN (IE, CF-700 TYPE)
$EOF
```



TURBOFAN - AFT-FAN (IE, CF-700 TYPE)

ALTP	=	25000.	AM	=	0.7500	VA	=	771.26	
DELTO	=	10.00	ETAR	=	1.00000	CS	=	1028.35	
HPEXT	=	0.	LCSL	=	0.	MCSL	=	0.	
PCBLOW	=	0.	PCBLOB	=	0.	PCBLNZ	=	0.	
PCBLC	=	0.	PCBLT4	=	0.	PCBLHP	=	0.	PCBLLP = 0.
PROA	=	8.000	BPR	=	2.000	WAENG	=	100.00	
PRFT	=	2.5000	ETAFT	=	0.84000	WA24	=	66.667	WA26 = 66.667
PRFH	=	1.0000	ETAFH	=	1.00000	WA21	=	33.333	BLLCSL= 0.
PRLP	=	1.0000	ETALP	=	1.00000	WA22	=	33.333	BLHCSL= 0.
PRC	=	8.0000	ETAC	=	0.85000	WA3	=	33.333	
DPD	=	0.01000	DPFH	=	0.	DPC	=	0.	

PRESSURES IN LBS/SQ INCH

P1	=	5.454	T1	=	439.52	H1	=	104.98	
P2	=	7.921	T2	=	489.18	H2	=	116.86	
P21H	=	7.921	T21	=	489.17	H21	=	116.86	
P21L	=	7.921							
P22L	=	7.921	T22	=	489.17	H22	=	116.86	BLOU = 0.
P22	=	7.921							BLOB = 0.
P3	=	63.367	T3	=	951.68	H3	=	228.91	BLC = 0.
P4	=	62.100	T4	=	2100.00	H4	=	544.02	WG4 = 33.923
DPB	=	0.0200	ETAB	=	0.98500	FAR4	=	0.01770	WF4 = 0.5900
P41	=	62.100	T41	=	2099.99	H41	=	544.02	BLT4 = 0.
P5	=	24.020	T5	=	1711.48	H5	=	433.92	WG41 = 33.923
PRTH	=	2.5853	ETATH	=	0.90000	DPT	=	0.00150	
P51	=	23.984	T51	=	1711.48	H51	=	433.92	BLHP = 0.
P55	=	10.005	T55	=	1411.21	H55	=	351.83	WG51 = 33.923
PRTL	=	2.3973	ETATL	=	0.89000	DPE	=	0.01500	
P56	=	10.005	T56	=	1411.21	H56	=	351.83	BLLP = 0.
P6	=	9.855	T6	=	1411.21	H6	=	351.83	WG56 = 33.923
P7	=	9.855	T7	=	1411.21	H7	=	351.83	WG7 = 33.923
P8	=	9.855	T8	=	1411.21	H8	=	351.83	BLNOZ = 0.
V9	=	1606.62	TS9	=	1210.68	HS9	=	298.68	WG8 = 33.923
P24	=	19.802	T24	=	663.35	H24	=	158.63	
P26	=	19.604	T26	=	663.35	H26	=	158.63	
P27	=	19.604	T27	=	663.35	H27	=	158.63	WG27 = 66.667
P28	=	19.604	T28	=	663.35	H28	=	158.63	WG28 = 66.667
V29	=	1538.46	TS29	=	460.06	HS29	=	109.90	

FAR41	=	0.01770	FAR51	=	0.01770	FAR56	=	0.01770	
FAR7	=	0.01770	FAR8	=	0.01770	FAR27	=	0.	
HV	=	17407.3	HV7	=	16444.6	HV27	=	-0.0	
CV	=	0.98500	V9	=	1606.62	V29	=	1538.46	

FN/WA	=	24.846	THG9	=	16.940	THG29	=	31.878	
ETAP	=	0.66216	ETATHM	=	0.36181	ETAO	=	0.23958	
SFCU	=	0.85489	FG	=	4881.7	FN	=	2484.6	

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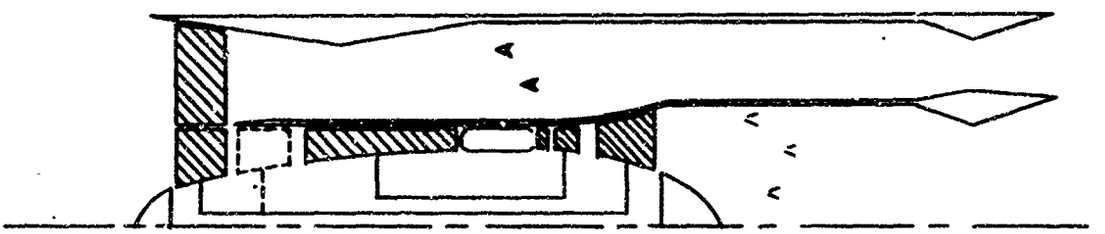
```
$DATA
 $INPUT ALTP=60000.,AM=2.6,PRES=14.696,WAENG=800.,BPR=1.7,
 CV=0.985,DPD=0.017,DPFH=0.0015,PRFT=2.7,PRFH=2.55,
 PRC=3.1,ETAFT=0.86,ETAFH=0.84,ETAC=0.86,ETATH=0.90,ETATL=0.90,
 T4=2660.,T27=2960.,DPE=0.02,ETAB=0.985,
 ETABFD=0.88,PCBLC=0.055,PCBLT4=0.035,PCBLH=0.02,
 DPB=0.02,DPBFD=0.06,ITITLE=1,IDBURN=1$
                        TURBOFAN - DUCT-BURNER
$EOF
```



TURBOFAN - DUCT-BURNER

	ALTP = 60000.	AM = 2.6000	VA = 2517.00				
	DELTO = 0.	ETAR = 0.85854	CS = 968.08				
HPEXT = 0.	LCSL = 0.	HCSL = 0.					
PCBLOW= 0.	PCBLOB= 0.	PCBLNZ= 0.					
PCBLC = 0.05500	PCBLT4= 0.03500	PCBLHP= 0.02000	PCBLLP= 0.00000				
PRUA = 7.893	BPR = 1.700	WAENG = 800.00					
PRFT = 2.7000	ETAFT = 0.86000	WA24 = 503.704	WA26 = 503.704				
PRFH = 2.5500	ETAFH = 0.84000	WA21 = 296.296	BLLCSL= 0.				
PRLP = 1.0000	ETALP = 1.00000	WA22 = 295.296	BLHCSL= 0.				
PRC = 3.1000	ETAC = 0.86000	WA3 = 280.000					
DPD = 0.01700	DPFH = 0.00150	DPC = 0.					
PRESSURES IN LBS/SQ INCH							
P1 = 1.040	T1 = 389.97	H1 = 93.13					
P2 = 17.806	T2 = 914.09	H2 = 219.63					
P21H = 45.404	T21 = 1231.60	H21 = 299.27					
P21L = 45.336							
P22L = 45.336	T22 = 1231.60	H22 = 299.27	BLOW = 0.				
P22 = 45.336			BLOB = 0.				
P3 = 140.542	T3 = 1723.64	H3 = 426.84	BLC = 16.296				
P4 = 137.731	T4 = 2660.00	H4 = 706.66	WG4 = 294.407				
DPB = 0.0200	ETAB = 0.98500	FAR4 = 0.01574	WF4 = 4.4067				
P41 = 137.731	T41 = 2628.87	H41 = 696.88	BLT4 = 10.370				
P5 = 56.659	T5 = 2184.27	H5 = 566.65	WG41 = 294.777				
PRTH = 2.4309	ETATH = 0.90000	DPT = 0.					
P51 = 56.659	T51 = 2175.59	H51 = 563.94	BLFP = 5.926				
P55 = 7.183	T55 = 1393.33	H55 = 346.10	WG51 = 300.703				
PRTL = 7.8877	ETATL = 0.90000	DPE = 0.02000					
P56 = 7.183	T56 = 1393.33	H56 = 346.10	BLLP = 0.000				
P6 = 7.040	T6 = 1393.33	H6 = 346.10	WG56 = 300.703				
P7 = 7.040	T7 = 1393.33	H7 = 346.10	WG7 = 300.703				
P8 = 7.040	T8 = 1393.33	H8 = 346.10	BLNOZ = 0.				
V9 = 2640.87	TS9 = 835.55	HS9 = 202.49	WG8 = 300.703				
P24 = 48.075	T24 = 1245.51	H24 = 302.83					
P26 = 47.258	T26 = 1245.51	H26 = 302.83					
P27 = 44.422	T27 = 2960.00	H27 = 814.75	WG27 = 520.020				
* * D/B * *	ETABFD= 0.88000	DPBFD = 0.06000	WF27 = 16.5167				
P28 = 44.422	T28 = 2960.00	H28 = 814.75	WG28 = 520.020				
V29 = 4982.69	TS29 = 1214.59	HS29 = 303.55					
FAR41 = 0.01518	FAR51 = 0.01487	FAR56 = 0.01487					
FAR7 = 0.01487	FAR8 = 0.01487	FAR27 = 0.03239					
HV = 16950.8	HV7 = 16444.6	HV27 = 16695.4					
CV = 0.98560	V9 = 2640.87	V29 = 4982.69					

FN/UA = 55.289	THG9 = 30.852	THG29 = 100.667	
ETAP = 0.68561	ETATH= 0.57501	ETAO = 0.39423	
SFCU = 1.74998	FG =105215.9	FN = 42631.4	

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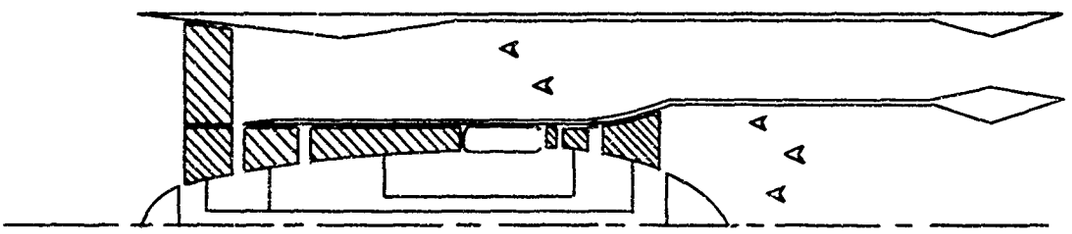
```
$DATA
 $INPUT ALTP=500.,AM=0.95,PRES=14.696,WAENG=170.,BPR=1.6,
 CV=0.99,DPD=0.03,PRFT=2.2,PRFH=2.1,PRLP=1.7,PRC=3.7,
 ETAFT=0.86,ETAFH=0.84,ETALP=0.87,ETAC=0.86,ETATH=0.90,ETATL=0.91,
 T4=2460.,T7=3200.,T27=3200.,DPE=0.02,
 ETAB=0.98,ETABAB=0.88,ETABFD=0.88,PCBLC=0.04,PCBLT4=0.024,PCBLHP=0.015,
 DPB=0.02,DPBAB=0.065,DPBFD=0.08,ITITLE=1,IAFTBN=1,IDBURN=1
                  TURBOFAN - A/B AND DUCT-BURNER
$EOF
```



TURBOFAN - A/B AND DUCT-BURNER

ALTP = 500. AM = 0.9500 VA = 1058.80
DELTO = 0. ETAR = 1.00000 CS = 1114.53

HPEXT =	0.	LCSL =	0.	HCSL =	0.		
PCBLOW=	0.	PCBLOB=	0.	PCBLNZ=	0.		
PCBLC =	0.04000	PCBLT4=	0.02400	PCBLHP=	0.01500	PC-LLP=	0.00100
PRDA =	13.209	BPR =	1.600	WAENG =	170.00		
PRFT =	2.2000	ETAFT =	0.86000	WA24 =	104.615	WA26 =	104.615
PRFH =	2.1000	ETAFH =	0.84000	WA21 =	65.385	BLLCSL=	0.
PRLP =	1.7000	ETALP =	0.87000	WA22 =	65.385	BLHCSL=	0.
PRC =	3.7000	ETAC =	0.86000	WA3 =	62.769		
DPD =	0.03000	DPFH =	0.	DPC =	0.		

PRESSURES IN LBS/SQ INCH

P1 =	14.432	T1 =	516.89	H1 =	123.49		
P2 =	25.794	T2 =	610.29	H2 =	145.88		
P21H =	54.167	T21 =	780.83	H21 =	187.04		
P21L =	54.167						
P22L =	92.084	T22 =	924.81	H22 =	222.27	BLOA =	0.
P22 =	92.084					BLOB =	0.
P3 =	340.710	T3 =	1382.96	H3 =	338.34	BLC =	2.615
P4 =	333.896	T4 =	2460.00	H4 =	649.06	WG4 =	63.876
DPB =	0.0200	ETAB =	0.98000	FAR4 =	0.01764	WF4 =	1.1069
P41 =	333.896	T41 =	2435.95	H41 =	641.61	BLT4 =	1.569
P5 =	142.646	T5 =	2037.14	H5 =	525.65	WG41 =	65.445
PRTH =	2.3407	ETATH =	0.90000	DPT =	0.		
P51 =	142.646	T51 =	2028.04	H51 =	522.88	BLHP =	0.981
P55 =	38.075	T55 =	1516.21	H55 =	379.92	WG51 =	66.426
PRTL =	3.7465	ETATL =	0.91000	DPE =	0.02000		
P56 =	38.075	T56 =	1516.08	H56 =	379.88	BLLP =	0.065
P6 =	37.313	T6 =	1516.08	H6 =	379.88	WG56 =	66.492
P7 =	34.898	T7 =	3200.00	H7 =	912.39	WG7 =	68.741
* * A/B * *		ETABAB=	0.88000	DPBAB =	0.06500	WF7 =	2.2495
P8 =	34.888	T8 =	3199.99	H8 =	912.39	BLMOZ =	0.
V9 =	2948.11	TS9 =	2647.98	HS9 =	735.23	WG8 =	68.741
P24 =	56.746	T24 =	788.47	H24 =	188.90		
P26 =	55.044	T26 =	788.47	H26 =	188.90		
P27 =	50.640	T27 =	3200.00	H27 =	905.53	WG27 =	109.376
* * D/B * *		ETABFD=	0.88000	DPBFD =	0.08000	WF27 =	4.7611
P28 =	50.640	T28 =	3200.00	H28 =	905.53	WG28 =	109.376
V29 =	3444.72	TS29 =	2434.50	HS29 =	663.66		
FAR41 =	0.01720	FAR51 =	0.01695	FAR56 =	0.01693		
FAR7 =	0.05153	FAR8 =	0.05133	FAR27 =	0.04551		
HV =	17117.6	HV7 =	16488.1	HV27 =	16488.1		
CV =	0.99000	V9 =	2948.11	V29 =	3444.72		

FN/PA = 73.028 THG9 = 37.052 THG29 = 68.885
ETAP = 0.49353 ETATH= 0.25138 ETAO = 0.12407
SFCO = 2.35391 FG = 18009.2 FN = 12414.7

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UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Air Force Aero Propulsion Laboratory Wright-Patterson Air Force Base, Ohio	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED 2b. GROUP

3. REPORT TITLE

DESIGN POINT TURBINE ENGINE PERFORMANCE PROGRAM

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

5. AUTHOR(S) (First name, middle initial, last name)

Witherell, R. E., Captain, USAF

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
September 1968	75	0

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
b. PROJECT NO. 3066	AFAPL-TR-68-88
c. 306603	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
d.	

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11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	Air Force Aero Propulsion Laboratory Wright-Patterson Air Force Base, Ohio

13. ABSTRACT

This report describes a digital computer program titled CARPET. CARPET is a computer program that calculates parametric turbojet/turbofan engine performance. It can also analyze the performance of a specific engine. The program is written in Fortran IV language and was designed for use on an IBM 7090 Digital Computer. Included in the report are listings of the complete program, various sample input data and the corresponding output.

DD FORM 1 NOV 65 1473

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Turbine engine computer						
Turbine engine cycle analysis						
Turbine engine parametric performance						